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PLATE XXIX.

Fig. 1.—Ufra of rice. Advanced stage of *pucca* ufra, showing the thinning of the stem above the top node and the discoloration at the base of the ear. Most of the grains are light. Specimen from Narayanganj. $\frac{5}{6}$ natural size.

„ 2.—Ditto from a Pusa inoculation. The stem lesion is less marked than in fig. 1 and the base of the ear is not affected. $\frac{5}{6}$ natural size.

„ 3.—Ditto from a Pusa inoculation, with sheath still in place, showing the characteristic symptoms of *pucca* ufra. $\frac{5}{6}$ natural size.

„ 4.—Ditto. A typical case of *thor* ufra of aus paddy from Begumganj. Natural size.

UFRA DISEASE OF RICE.

BY

E. J. BUTLER, M.B., F.L.S.,

Imperial Mycologist.

DISEASES of rice are, fortunately, not common in India. Compared with the other staple cereal crops of the country, wheat, millets, etc., the rice plant is remarkably free from serious fungus enemies. Of the two main classes of fungus diseases of cereals, rust and smut, the first is unknown on rice, the second rare. Insect pests are numerous, but usually they attack single plants scattered through the fields and, though responsible in the aggregate for great losses, the individual ryot gets a crop which repays him for his labour and is, therefore, not inclined, as a rule, to take them seriously.

In 1908, however, a disease of a new and much more virulent type was reported to be ravaging the paddy crop in the districts of Noakhali and Tippera at the head of the Bay of Bengal. It had been known for a good many years but had recently increased in severity to such an extent as, according to local correspondents, to bring the cultivating classes to the verge of ruin. The cultivators called it *ufra*, from "upara" meaning "above," associating it in some mysterious way with the sound of the "Barisal guns," a curious booming noise heard in the autumn in the Sundarbans and deltaic districts of Eastern Bengal.

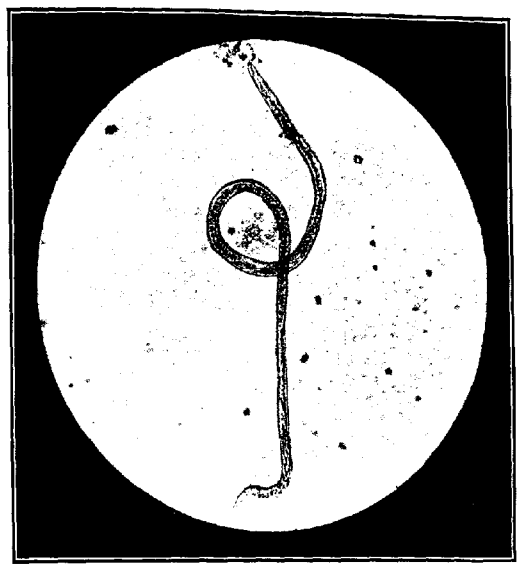
Further enquiry has shown that the disease also occurs in the district of Dacca. Excepting these three districts it has not been heard of elsewhere as yet, but it is spreading and may be discovered before long in neighbouring districts.

The symptoms of ufra are sufficiently characteristic, though in the earliest stage the cultivator recognises that his crop is affected, through signs which might readily escape the notice of a less expert observer. At about the fourth or fifth month of growth, the tips of the leaves are found withering and the young shoots are pale and flaccid. Later on, brown stains appear on some of the upper leaf sheaths. Little else is noticed until the plants are about to come into ear. At this stage many plants are found with the top of the shoot swollen into a spindle-shaped thickening, which, on examination, is discovered to consist of the immature ear, enclosed in its sheath. In very many cases the enclosed ear remains thus imprisoned up to harvest, when it is generally found mouldy and rotten. This condition is known as *thor* (swollen) ufra. In other cases the ear escapes wholly or in part from the sheath, but the lower grains fail to develop and the upper are usually shrivelled. The term *pucca* (ripe) ufra is applied to this form. The upper sheaths, especially that which surrounds the ear, are withered or marked with characteristic brown stains, as may be seen depicted in the plate accompanying this article. On removing these sheaths the stalk is found blackened and shrunken for an inch or so just above the upper stem joints, especially the joint which carries the ear and that next below. Other minor symptoms are sometimes present, but the above are the usual outward signs of the disease.

The cause of ufra remained obscure for some time after its investigation was commenced. Recently, however, it has been determined to be due to a minute worm, belonging to the nematode or eelworm class, several of which are known to live parasitically on animals and plants. The species which causes ufra is one not previously known, but it belongs to a genus (*Tylenchus*)* in which are included two of the worst worm parasites of cereals. *Tylenchus tritici* causes the well-known ear cockles of wheat, which is found in the Punjab and is common in Europe; *Tylenchus dipsaci* lives in the stem of several cereals,

* A more technical account of the disease and of the organism which causes it, is in the Press as Bulletin No. 34 of the Agricultural Research Institute, Pusa.

as well as in clover, onions, potatoes, etc. The rice parasite is allied to the latter, but is smaller and lives on the outside of the tissues, not embedded in them as is the case with *Tylenchus dipsaci*.



The parasite (*Tylenchus*) which causes ufra. Much magnified.

In the earlier stages of attack the worms are found chiefly in the inner layers of the leaf-bud in the neighbourhood of the growing point of the stem. In *thor* ufra they congregate on the shrunken, blackened portion of the stalk and at the base of the ear. Some are also found within the empty glumes of the ear. In *pucca* ufra they are found in the same places but the ear is more extensively infested, the worms lying within the glumes but outside the grain proper, when one is developed.

The individual worms are very minute, usually less than one-twenty-fifth of an inch in length, by one-fifteen-hundredth of an inch in breadth. They are therefore practically invisible to the naked eye. When a large number congregate in one spot, they

form a whitish cottony mass. Adult males and females, larval forms and eggs are usually found intermingled. As in the other species of the genus, the mouth of the adult is furnished with a minute spine, which can be protruded and retracted when feeding. The œsophagus has a stout muscular bulb, by the movements of which the plant juices can be sucked up, after the cell wall has been pierced by the spine.

The number of eggs laid by the female is not known, but is probably between 50 and 100. In *Tylenchus tritici* as many as 2,000 are laid. If the rice worm lays 100, which all reach maturity and are equally male and female, one pair could produce a quarter of a million individuals in three generations. It can readily be seen that the powers of multiplication of such a parasite are immense.

Up to the present it has only been found on rice. A wild grass was reported in one instance to suffer from the same disease as the neighbouring paddy, but the observation has not been confirmed. On rice the worm has only been found on the above ground parts, where it tends to work its way under the leaf sheaths and round the edges of the inrolled leaves into the heart of the bud. It has not been found in the roots, in the soil or on the numerous weeds which occur in the paddy fields. Naturally such a search is difficult and it is by no means certain that it

rising of the rivers in the hot weather and early in the rains. Hence active spread of the disease is confined to the second half of the year. How many generations occur within this period is not known, but there appear to be not less than three.

The observations so far made indicate that the parasite is restricted in its choice of food to living paddy plants. It neither feeds, nor multiplies, except when it is living on the growing crop. As soon as the crop is ripe it coils up and becomes dormant. It is true that it must travel through the water from plant to plant during the time when infection is actively going on, and we have found by experiment that if placed in water at the base of a paddy plant, it will climb up above the water level and work its way into the heart of the leaf-bud: but it does not seem to feed or multiply except on the plant itself, and if kept in water soon becomes sluggish. The experiments on this point are, however, not conclusive, as it is difficult to imitate all the conditions which may affect the natural life of the worm, when carrying out experiments in the laboratory.

In feeding on the rice plant the worm is restricted to such parts as are without strongly thickened cell walls in the outermost cell layer. The spine by which it pierces the wall to suck the juices, is small and very slender. It is entirely unfitted for the penetration of a stout or rigid barrier. This explains the peculiar localisation of the injuries on the stalk, ear and leaves. The outer wall of the stalk is thick and silicified, except for a short distance just above each joint, especially towards the top. Here it is thinner and flexible and here alone the stalk is attacked, causing the blackened shrunken areas well seen in Plate XXIX. The young ear is also not protected by thick outer walls. Large numbers of worms have been found feeding in this locality. The same is true of the young inrolled leaves which form the inner layers of the bud and also, to a less extent, of the inner surface of the leaf sheath, especially towards the free margins. It is in these last positions that the parasite is always found in the earliest stages of the attack.

In considering the amount of damage capable of being caused by this disease, and the possibility of its effective check, account must be taken of the conditions of paddy cultivation in the infected area.

In the three districts mentioned paddy is the staple crop, occupying over 70 per cent. of the cultivated area. About 3,000,000 acres of paddy are sown every year, though, as the land from which two crops of paddy are taken in the year is counted twice, the net acreage under the crop is probably only from $2\frac{1}{2}$ to $2\frac{3}{4}$ million acres. The total outturn is about 1,100,000 tons of clean rice. It is clear therefore that the interests involved are very great.

As is usual in the Eastern Delta Districts of Bengal, there are three main crops of paddy in the year, the "aus," the "aman" and the "boro," each sub-divided into a number of varieties or races.

The "aus" is sown, in this area, from the middle of February onward to the beginning of May, depending to some extent on the character of the land and on the season, and is harvested from July to September. It is usually grown on land slightly higher than the rest of the paddy fields, a few inches being often enough; the object being to select land which will not get deeply submerged in the early part of the monsoon. In much of Noakhali, however, "aus" is grown on low lands (but not the very lowest) mixed with "aman" and sown as early as possible, each crop being harvested as it ripens; early maturing varieties of "aus," harvested in July or the first half of August, being selected for these low lands. "Aus" is almost always broadcasted, though a little is transplanted. About one-third of the gross area is sown with "aus." It yields less than the "aman" and the grain is inferior to the better class of the latter.

The "aman" may be divided into two main classes, the long stemmed or deep-water rices, which form the bulk of the crop in this area and are sown broadcast alone or (especially in Noakhali) mixed with "aus," in March to the beginning of

May, and the transplanted or short stemmed "aman" ("sail" or "roá") sown in seed beds from May to July and transplanted in August and September. Both classes are harvested in November and December. The deep-water varieties are coarse and withstand flooding to a remarkable extent, being said to grow as much as 9 inches in 24 hours and to reach a length sometimes of 20 feet. When grown mixed with "aus" they are known as "bajal," the mixture being half and half or, more often, one-quarter "aman" to three-quarters "aus," in Noakhali. The deep-water rices are grown in the lowest lands and in some places, where the inundation is early, have to be sown in February. They keep pace with the rise of water and at harvest only the ears and 1 to 1½ feet of stalk are cut, the rest, often many feet in length, being left as stubble. A cold weather crop of pulses, such as Khesari (*Lathyrus sativus*), is sometimes sown on top of the paddy just before harvest.

Transplanted "aman" is grown either as a single crop, or as a first crop followed by cold weather pulses, or as a second crop following "aus" paddy or jute. The best varieties are grown on the higher lands. In the Western part of Noakhali little transplanted paddy was grown until recent years, according to local information, but there is now about 20 per cent. of this class in the neighbourhood of Chaumuhani. This is partly due to the extension of jute cultivation, the transplanted paddy being taken as a second crop, partly to the ravages of ufra on the broadcasted crop. The seed is grown in seed beds until the jute or unmixed "aus" is harvested, then transplanted into the higher fields after a few ploughings at the end of August or in September.

"Boro" paddy is of much less importance than the other two, being practically unknown in Noakhali and occupying only a comparatively small area in the other districts. It is grown on muddy land along the rivers and creeks. It is generally transplanted, but sometimes broadcasted on the mud flats. When transplanted, the seed is sown in late October or November, and planted out, usually without any previous preparation of the

land, in December or January. Irrigation is required, except where tidal water reaches the fields. Harvest is in April or May. The yield is heavy but the grain is coarse. Broadcasted "boro" is sown in December or January and harvested at the same time as the transplanted.

It will thus be seen that the chief paddy harvest is in November and December. The broadcasted "aman" (including the "bajal") leaves a quantity of coarse stubble in a matted mass on the still damp fields. This stubble is almost worthless as cattle fodder but the cattle are often turned loose to pick up what they can of weeds or rotting stubble in the fields. In the northern part of the district under consideration the fields are sometimes raked clean and the *debris* burned, but this is certainly rare in Western Noakhali. Ploughing is said to be sometimes done immediately after harvest but this again is unusual in Noakhali, where the first ploughing of the low lands appears to be usually in February, after a fall of rain. The early showers in February and March are extremely important in softening the heavy clay of the land subject to inundation, sufficiently to admit of ploughing with the inferior work cattle of the district. The fields which grow cold weather pulses, sown in the mud before the paddy harvest, are not worked until these crops are harvested. What remains of the stubble is often collected for fuel before ploughing begins. Five or six ploughings are given in February and March, or later in the higher lands. The tillage operations naturally vary in the different qualities of land and for the different classes of paddy it is intended to grow, but, as far as I can ascertain, the low land, on which deep-water "aman" and "bajal" are grown gets less cultivation than the others and may even be under paddy for 9 or 10 months of the year, and have stubble on them for a month or more after harvest.

Ufra has been found in "aus" and "aman" but has not as yet been reported in "boro" paddy. In Noakhali the first attack is found in the "aus" crop, both that grown alone (not common) and that in the "bajal" mixture, about the end of June, when the crop is beginning to come into ear. It occurs at

first in patches which do not spread with great rapidity: though the loss in a given patch may be complete, the total amount of damage to the "aus" crop is not large, as harvest occurs before the attack is widespread. At the time of the severest "aus" attack early in August, the broadcasted "aman" is still less than half grown and shows no sign of ears. Careful examination indicates that the latter crop has, however, the early symptoms of disease even at this stage. It is, indeed, probable that signs of infection could be detected in the "aus" before June, but an opportunity has not occurred for examination in the early stages of its growth. In the broadcasted "aman," whether alone or mixed with "aus," whole fields may be clearly diseased in late August and September. It is probable that there is no real difference in susceptibility between the "aus" and the "aman," but that there is a progressive multiplication of the cause of the disease insufficient to do much harm to the former but capable of great damage to the latter owing to its longer period of growth.

It is possible to find plants at the margin of spreading patches of disease, especially in "aus" paddy, showing some shoots with normal ears, others with different stages of *thor* and *pucca* ufra. Towards the centre of such patches, where the disease has been longer in progress, every ear is generally affected. Fields were seen where the loss did not exceed ten per cent. and others where it was practically complete. In "aman" paddy the intensity is generally high, as the long growth period allows the parasite to multiply greatly.

Perhaps the most remarkable circumstance in connection with the disease is the comparative immunity of transplanted paddy of any kind to natural attack. Transplanted paddy appears to be never severely attacked. Indeed it is not certain that it is ever attacked at all, but some suspicious cases were seen in transplanted "aman" about harvest time. These were, however, complicated by the attack of aphids and borers. On the other hand it is quite easy to inoculate transplanted paddy artificially, either by inserting a piece of diseased culm, bearing living worms, under the leaf

sheaths, or by merely placing similar pieces in the water at the base of the plant. Hence it is, apparently, not so much any inherent difference in the susceptibility of transplanted paddy to attack that explains why the transplanted crop as a rule escapes, as some peculiarity in the behaviour of the parasite which prevents it from reaching the crop. It is not yet clear what this peculiarity can be.

Owing to the backwardness of the affected tracts and the comparatively recent date of the organisation of the local Department of Agriculture, accurate information as to the extent of the area affected with ufra, and the amount of damage caused, is not yet available.

In Noakhali District the disease occurs throughout the central and western portions of the district, information of its existence in Sudharam, Begumganj, Ramganj and Lakhipur thanas having been obtained. In Begumganj thana the loss in 1910 was roughly estimated at 200,000 maunds of grain. Around Chaumuhani I was told that nearly half of the winter paddy was lost in 1911. From my own observations I should think this was an under- rather than an over-estimate. The disease is said to have been known in this neighbourhood for about 30 years. It began to increase some 20 years ago and to cause serious damage more recently. Several middle-aged men told me that it was unknown in their fathers' time and has much increased during the past six or eight years. This is perhaps as near as we can hope to get to its history.

In Tippera it is known to be prevalent near Chandpur, no doubt as a northward extension from Noakhali, and also around Comilla. The intervening area is probably more or less infected, especially as it is said to occur south of Laksam. The intensity of the disease is not known.

In Dacca, according to the District Gazetteer, considerable areas in the Madhupur jungle were destroyed in 1904 and 1905 "by a mysterious blight called *dak* which the villagers described as a vapour issuing from the ground but which appears to have been an obscure form of blight." Specimens of *dak* were first

sent to Pusa in 1911 and proved to be identical with the ufra of Noakhali and Tippera. In 1912 deep-water "aman" paddy was attacked by *dak* in the Narayanganj sub-division. The Mycological Collector of the Bengal Department of Agriculture, Babu A. L. Som, reported that the disease had been known for some ten years, but had only become serious within the past five years. It was said not to attack the "aus" crop. His collections showed that the attack was a typical and very severe one. Another large outbreak has been reported quite recently around Bikrampur and is said to extend to the west and north-west for a considerable distance towards the main stream of the Padma. It is certain that, as attention is directed to the pest by these enquiries, new localities will be revealed. It is not probable that these will represent areas of new infection. The evidence so far is that the disease spreads slowly, and apparent new extensions will be for the most part merely the result of more careful enquiries for some time to come. It is hoped to arrange for a survey of the infected tracts during the coming year. Those who know the means of communication available in the districts mentioned, during the paddy season, will appreciate the difficulties of this task.

It is obvious that the best methods to adopt in fighting this disease cannot be decided on in a few months. Experiments will have to be carried out within the affected area and, as in all crop experiments, may have to be repeated for several years before reliable results are obtained. Still, as the need is pressing, there are several measures which can be advised for immediate practice and some of these have been already recommended and are being tested by the cultivators themselves.

All the possible measures to be considered may be divided into those directed against the parasite and intended to lead to a reduction in its numbers, and those whose object is to render the host plant less susceptible to damage.

Into the first group fall all attempts to kill the parasite. It is, I think, useless to try any direct attack on it while it is actively swarming in the fields during the growth period of the

plant. Spraying a crop like paddy in India may be at once dismissed as impracticable. The addition of some vermicide to the water on the fields might be feasible were it not that the majority of the worms are out of reach of the water in the inner layers of the bud and towards the top of the plant. The cost of dealing with any large area would also probably be prohibitive. During the cold weather months, when the worms are inactive in the stubble and grain, direct attack is more hopeful. Success at this period will depend on several factors. There is, first, the ability to destroy any large proportion of the worms in a given crop. Secondly, destruction must be carried out over a sufficiently large area to prevent reinfection. With a motile organism and large movements, tidal and gravitational, of the surface water, the chances of reinfection will probably be considerable. There is, thirdly, a possibility that the disease will be found in some localities in the "boro" paddy, a crop which grows during the only months when active measures are feasible. This is, perhaps, not an important difficulty, as "boro" paddy is not as yet known to get the disease and is besides confined to certain well-defined tracts. It need not, for instance, enter into calculation at all in Noakhali District.

I believe that it will be found possible to reduce the parasite considerably by burning all the stubble left after the harvest of the winter rice. It may be necessary to supplement this by securing worm-free seed and by some cultural treatment of the soil. A certain proportion of the worms undoubtedly pass the early part of the period after harvest in the stubble. Others equally certainly go to the grain heaps through ears affected with *pucca* ufra. Whether any remain alive during this period in the soil is not yet certain. The evidence, so far as it goes, suggests that these last two lots of worms are not of great importance in renewing the disease. If the disease were commonly seed-borne, extension would probably have been much more rapid than has been the case, as exchange of seed from one locality to another goes on to some extent. If it were soil-borne, the soil of transplanted paddy fields would certainly have been infected long

ago, especially as it is the practice at the end of the cold weather to spread soil from the lowest land on to the fields intended for jute and from which a second crop of transplanted winter paddy will be taken. We know from the inoculations that these plants will get the disease if the parasite reaches them and we may, therefore, conclude that it is not present about the time of transplanting.

Some encouraging reports of the beneficial effects of burning the stubble have already been received, the recommendation to do so having been made last year by both Mr. Fletcher, Officiating Imperial Entomologist, and myself. The damage done by borers in the districts affected with ufra is such that Mr. Fletcher strongly advised burning the stubble as a regular agricultural routine. The practice is widespread in other parts of Bengal and should be introduced everywhere that ufra or serious damage by borers occurs.

Experiments on the effect of more thoroughly working the soil of the lower paddy fields than is customary are advisable, as even though the worm may not remain alive ordinarily in the soil, it is likely to be found in shed grain and fragments of stubble on the surface. By ploughing these in there is a prospect of their speedy decomposition and consequent death of the worm if, as the evidence suggests, it is unable to live long in moist soil. There are difficulties in the way, however, since much of the lower land gets very hard after harvest and has to be softened by the spring showers before the local cattle can plough it. Furthermore, the peculiar nitrogen relations of rice are such that there is a danger of causing a serious loss of nitrogen or the accumulation of poisonous nitrites by over-cultivation.

Should it be found that the use of infected seed is more dangerous than at present appears to be the case, steps will have to be taken to ensure a supply of healthy seed. This will require some organisation but should not be beyond the power of the local Department to undertake.

Into the second group of prophylactic measures fall all efforts to improve the health of the plant and to grow it under conditions

which will render it less liable to infection. The practice of transplanting should be encouraged wherever possible, owing to the observed freedom from ufra of the transplanted crop. It will probably be objected that transplantation on a larger scale than at present is not possible, owing to the nature of the annual inundation, but I am by no means satisfied that this is the case. The mere fact that the transplanted area near Begumganj has considerably increased in recent years, partly as a result of the extension of jute cultivation, is sufficient to disprove it. The people are already transplanting more than they did and would probably do so still more if urged. Transplanting is much more troublesome than broadcasting and the cultivators in Noakhali, as in certain other paddy tracts, are uncommonly lazy. In these matters influence counts for much and I think a good deal can be done towards increasing the transplanted area.

Liming the soil was tried, at the instance of the Bengal Department of Agriculture, in 1912. It appears to have had the effect of delaying the first appearance of the disease but not saving the crop. The cost is so high in Noakhali District as to make it doubtful if it can be used on a large scale.

The evidence, so far as it goes, appears to suggest that rice is more susceptible to ufra when it is grown under conditions which preclude the aeration of the soil throughout the greater part of the year. It is true that inoculations in fairly permeable soil succeeded at Pusa, but the attack was not so severe as is commonly met with in the submerged paddy fields near Begumganj. The growth of deep-water broadcasted paddy in a great deal of this area cannot be avoided, owing to the nature of the levels, but something might be done to promote drainage over considerable areas. The improvement of natural drainage in Lower Bengal has been prominently before Government for some time and any steps in this direction, in the districts affected with ufra, will probably help in reducing the losses caused by the disease.

A serious disease of rice is one of the greatest calamities that could befall the people in districts such as those referred to

above (where nearly three-quarters of the cultivated area is under paddy) for no other food crop can replace it. When, in addition, the disease is of a highly infectious nature, as the results of the inoculations show it to be in this case, the risk of spread to other areas is even a more important consideration than the losses caused within the infected area itself. On the one side is the whole of the enormous paddy area of Bengal: on the other, at a greater distance but joined by an almost continuous belt of paddy cultivation, is the Irrawaddy Delta, which supplies the bulk of the export rice of India. Were it certain that transplanted paddy would remain immune, the greater part of these areas might be regarded as not exposed to serious risk. But transplanted paddy has been artificially inoculated and it is not safe to rely on its apparent immunity. No reports of the disease having appeared west of the Brahmaputra have been received. The Irrawaddy Delta is also free from it, so far as I was able to determine during a recent tour in Burma, though several little known and comparatively unimportant rice diseases were found.

Rice is perhaps less subject to disease than any other important cereal. The appearance of a new disease of such intensity that the crop in many fields in the infected districts has been found not worth harvesting, is an occurrence that commands attention. In more advanced countries it is probable that a special staff would be deputed to secure an immediate thorough investigation. We have not yet reached the stage in India where this is possible and the available staff has many other calls on its energies. The Government of Bengal have set aside Rs. 11,000 during the current year, for the trial on a large scale of measures calculated to check the disease. It is hoped shortly to obtain further information on some of the points which still remain obscure in the life-history of the parasite and the behaviour of the host plant to its attack. In collaboration with the Bengal Department, we shall then be in a position to fight it on more rational lines and with better prospect of success. At present our recommendations are more or less tentative and we

must await the results of the experiments which have been planned or are already in progress before undertaking the work on a scale commensurate with the importance of the subject.

THE WORLD'S CANE-SUGAR INDUSTRY.

A REVIEW.*

BY

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PART I.

HISTORICAL.

ATTENTION has been attracted by the increase that has taken place in recent years in the production of sugar manufactured from sugar-cane, partly as the result of the altered politics of certain countries and colonies, and partly owing to the increased care paid to the business and scientific sides of cane cultivation and manufacture.

The following table will show the change from the time when cane-sugar was first threatened, and then in danger of being wiped out, by the competition of the privileged beet-sugar in the European market, to the present day, when cane-sugar is holding its own, and when a position of equilibrium has been established, that seems likely to last.

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* This is a review of "The World's Cane-Sugar Industry, Past and Present" by H. C Prinsen Geerligs. Price 12/ (N. Rodger, Altrincham, Manchester).

TABLE I.

World's Production of Sugar excluding British India.

YEAR.	Tons. Beet-root Sugar.	Tons. Cane-Sugar.	Total production.
1859-60	451,584	1,340,980	1,792,564
1864-65	529,793	1,446,934	1,976,727
1869-70	846,422	1,740,793	2,587,215
1874-75	1,302,999	1,903,222	3,206,221
1880-81	1,820,734	2,027,052	3,847,786
1884-85	2,679,400	2,225,000	4,904,400
1889-90	3,536,700	2,138,000	5,674,700
1894-95	4,725,800	3,531,400	8,257,200
1899-00	5,410,900	2,880,900	8,291,800
1902-03	5,208,700	4,163,900	9,372,600
1904-05	4,870,000	4,776,000	9,646,000
1909-10	6,588,000	6,177,000	12,765,000
1911-12	6,801,000	6,548,000	13,349,000

Mr. Geerligs' book on the World's Cane-Sugar Industry, Past and Present, appearing at the moment when the industry has taken a new lease of life, is of great interest to both the technical and general reader; and of especial interest to India, which has from the remotest ages had an enormous acreage annually under cane.

Until recent times India has been singularly unmoved by the political and social commotions, that determined the location of the sugar-producing crops. Able to produce sufficient for its not extravagant needs, and even in times gone by to export, it went on its way unmoved; and it is now a matter for speculation whether the Indian people will put their house in order, and take advantage of the changed conditions to increase their out-turn of sugar to meet their expanding appetite for this article of diet, or leave the profits of doing so to other countries. Will

they grow their own sugar, or pay the enterprising inhabitants of Java, Mauritius, and probably Formosa and the Philippines, to do so for them?

Anyone interested in this subject will be well repaid by reading Mr. Geerligs' work. The early history of sugar is told with great clearness and charm, and without the technological detail which, as a rule, tries the patience of the general reader.

Sugar-cane and a crude sugar made from it were found by the Crusaders on the shores of the Levant, whither it had been taken, probably from India, by the Saracens. It was introduced into Spain as early as 750 A.D., where, it may surprise many to learn, it still exists as an industry.

The growth of cane and manufacture of sugar, then a rare and highly appreciated delicacy in Europe, was extended and fostered by the Crusaders, and the semi-religious knighthoods established by them, wherever possible, and from the shores of the Mediterranean the sugar consumed by Mediæval Europe was procured.

The extension of the Turkish dominions, and the general break up of Mediæval Society threatened this source of supply, and caused the Portuguese and Spaniards to introduce it into their colonies of Madeira, the Azores, and West Africa, whence they supplied the sugar required by the European market.

The discovery of the new world, opening up an unrivalled field for human activity, provided a new home for the sugar-cane. Thither it was carried by the early voyagers, and flourished exceedingly on a fertile soil in a favoured climate. Fostered by the introduction of slaves and assigned labourers from Europe, the industry developed enormously, and sugar, from being a delicacy procurable only by the rich, became an article of universal consumption.

From the end of the 17th, during the 18th, and in the early part of the 19th century, the European colonies of the West Indies and the Americas were the main producers of the world's supply of sugar.

Their supply, inadequate to meet the increasing demands in the early days, was supplemented by imports of raw sugar by the Dutch and English East India Companies, but as the production of the colonies of the new world increased, this trade languished.

The rich West India Planter is a familiar figure in the literature of the period, but the days of unrivalled prosperity were not to go on for ever. Rumours of the abolition of slavery were in the air; and in the middle of the 18th century two events happened, which were destined ultimately to strike a fatal blow at the supremacy of the Cane Industry.

In 1776, a motion for the abolition of slavery was brought before the British Parliament; and in 1747 Maggraf communicated to the Royal Academy of Science and Literature in Berlin the discovery of a crystalline sugar in beet-root. The effect of neither of these events was, however, felt at the moment. The long-planned abolition of slavery did not become a settled fact in the British dominions until 1834, other European Colonies liberating their slaves a little later.

About 1840-1850, when the abolition of slavery had had its effect on the cane production, the manufacture of beet-sugar in Europe began to make great progress. Greatly favoured by the various continental governments, the process of manufacture had been improved, and more and more sugar was extracted from the beet. The industry was, moreover, enormously assisted financially by the system of levying the sugar excise on the raw material, and not on the finished product. The tax was settled on the assumption that a certain fixed quantity of sugar was extracted from the beet, but, with improvements in manufacture, this figure was soon exceeded.

The duty paid was returned on all sugar exported, and as this return of duty, or rebate, was calculated on the finished product, a manufacturer who exported all his sugar received back from the excise more than he actually paid, because he was extracting more sugar from the beet than the amount fixed as the basis of taxation, of the raw material.

This financial assistance did not matter much as long as the continental exports remained insignificant, but, when the competition of beet-sugar became acute in the seventies, it had the most detrimental effect on the Cane Industry. The unnaturally stimulating effect of the bounty system in Germany and Austria-Hungary, the two most successful beet-growing countries, led to an abnormal production of sugar. This the manufacturer exported to his great profit at the expense of the consumer in his own country, and when the crisis in the trade came, he did not pocket the whole of the premium he was receiving from his own tax-payer, but shared it with his customers in other countries, in order to get their custom, and if possible to secure complete control over the production, and stifle competition. In other words, beet-sugar was exported and sold under the cost of production.

The cane-growing countries were badly hit, particularly our own West Indian Colonies. The conditions of their labour market were far from settled or satisfactory. They had not begun, or in a few rare cases only just begun, to pay attention to scientific methods of cultivation and manufacture, and were not in a position to put up a good fight against so powerful a rival as the highly organised beet industry had become.

The production of beet-sugar went up by leaps and bounds until in the year 1899-1900, just before the Brussels Convention. 2/3 of the world's production of sugar (excluding British India) was made from beet.

The fact that cane-sugar did not entirely disappear in those cane countries which relied on Europe for their market, is due, Mr. Geerligs thinks, to the fact that the producers could think of nothing a little more profitable to grow in its place, so that they were obliged to struggle on, however hard-pressed they were, to make both ends meet.

Mr. Geerligs' statement of the attitude of Great Britain during this period is as follows :—

"The British consumers were greatly pleased with the existing state of affairs and did not think it wise to interfere for

the sake of their colonies. Great Britain, which was not a sugar-producing country, though a great consumer of sugar, was doubtless the very best market for sugar exported by the principal producing countries; and, being compelled to dispose of their produce abroad, the exporters offered their goods to the British market even below cost price, just for the sake of the bounties held out to them. Owing to the rivalry among the continental producers, the British consumers, especially the preserve manufacturers, who were in the habit of using enormous quantities of sugar, got as much sugar as they wanted at a price at which it was impossible for them to produce it themselves. One can imagine that they wished this advantageous, though abnormal, condition to continue, and that they did not approve of measures put forward by their own government to put an end to the system for the sake of the West Indian colonists.

By the nineties, however most countries, concerned in paying them were getting heartily tired of the once approved bounties, and fervently wished to see them abolished. The British Government of the day, moreover, began to view with alarm the prospect of the total extinction of sugar production within its own dominions, and when the last Brussels Convention met in 1901, after attempts on the part of the representatives of the beet-growing countries to do their best for their own manufacturers, the balance was turned by Great Britain throwing in the weight of her influence against the bounty system, which was finally abolished by the signing of the Convention on March 5th, 1902, by the representatives of Germany, Austria, Belgium, Spain, France, Great Britain, Italy, The Netherlands, Sweden and Norway.

The subject of the Brussels Convention is too near the region of active politics to be further discussed in this article. It is however unquestionably the fact that the condition of the cane-growing countries has improved since the bounties were abolished. They are now able to hold their own, and appear likely to be able to do so in the future.

The Cane Industry, to quote Mr. Geerligs, "will not be able to oust the beet-root sugar manufacture, as an ever growing consumption draws on both kinds of sugar, and consequently gives both of them a chance to spread and flourish."

As will be seen by reference to Table I, the relative positions of the two industries are now about equal. The extent to which each will expand depends entirely on the ability displayed in the discovery and adoption of improved methods of cultivation and manufacture.

In the event, however, of another acute struggle, the Beet Industry will not find the cane countries unprepared, as they were in former times. Science has made its way to the tropics. The Biologist, the Chemist, and the Engineer, are at work in the cane fields and factories, applying modern methods of research to the problems of the Cane Industry.

Improved varieties are being created, tested, and distributed. Splendidly equipped Central Factories employing the best methods of milling, defecation, and evaporation, are making white sugar on the spot, and the old and wasteful processes are being abandoned. The yield of sugar per unit area is being increased almost everywhere except in India. As the author of the book under review puts it: "The Cane Industry knows far better how to turn to account any given area than it used to do before the crisis."

PART II.

Recent Development in different Countries.

The second part of his book Mr. Geerligs devotes to a detailed study of the position of the Cane Industry in various countries, and much valuable information, not hitherto easily obtained, is collected and arranged in a masterly manner.

Production was distributed amongst the more important cane-producing countries in 1910 as follows :—

India	...	2,125,000 tons.
Cuba	...	1,804,000 „
Java	...	1,278,000 „
South America and Mexico	...	708,000 „
Hawaii	...	463,000 „
United States	...	335,000 „
Porto Rico	...	305,000 „
Mauritius	...	252,000 „
Formosa and Japan	...	270,000 „
West Indies	...	282,000 „
Australia	...	148,000 „
Demerara	...	115,000 „
Philippines	...	112,000 „
Egypt	...	59,000 „

Java and Mauritius supply a large proportion of the white sugar imported into India, and are the competitors of the Central Factory in this country. A knowledge of the conditions of cultivation and manufacture in those islands is, therefore, of importance and value to the proprietors of Indian Factories.

The Sugar Industry in Formosa, Japan, and the Philippines, is on the point of great development, American capital is pouring into the latter country; and, owing to their geographical positions, they are all likely competitors of Java and Mauritius in the Indian market. If not in the immediate future, they are liable to become so at any time should the fiscal systems of the United States of America or Japan change; and a consideration of their possibilities is well worth study from an Indian point of view.

Java.

Java has been foremost among the cane countries to put their sugar industry on a sound business and scientific basis, and, thanks to this organisation, was able to take immediate advantage of the changed conditions in 1903, and has now outstripped all other countries as an exporter of white sugar to British India.

The following table gives the exports from Java and Mauritius to British India from 1894-95 to the present day, and shows the enormous increase that has taken place in the exports from the former country :—

TABLE II.

Exports of Sugar to British India.

YEAR.	From Java. Tons.	From Mauritius. Tons.
1894-95	7,692	... ...
1899-00	12,862	82,055
1904-05	96,622	76,382
1905-06	67,746	107,742
1906-07	149,929	133,767
1907-08	319,251	109,338
1908-09	312,662	126,129
1909-10	390,376	147,960
1910-11	445,621	136,472

Java possesses many natural advantages to mark it out as a successful cane-growing country—a rich alluvial soil, an equable temperature, and it is well watered by many rivers. The system of cane-growing resembles that in India in one respect, the cane is grown on land that is not the planter's property, but is rented by him for a single crop, or for a small number of years; but it differs from the system in many parts of India in this detail, that the cultivation is under direct control, and supervised by the factory authorities.

The Dutch Government keeps a very careful eye on the cane cultivation, but the conditions and attitude of this government towards the colonies and their inhabitants, as well as the problems with which it has to deal, differ so widely from those in India that comparison is difficult.

The planting is exclusively done on irrigated land, and a triennial rotation of crops is practised. Mr. Geerligs gives the following as a typical scheme of cropping :—

September	... Cane crop.
September to November ...	... bean, maize, etc.
November to April ...	... rice.
April to November ...	... fallow, beans, indigo, etc.
November to April ...	... rice.
April to September of the following year	... cane.

The cane is planted in rows 4—5 feet apart, 1 foot deep and 1-1·5 feet wide. As the cultivation only allows one crop, and ratoons are unknown, every effort is made to secure a bumper one.

The crop is very generously manured. Manures supplying Nitrogen are almost exclusively used, chiefly Sulphate of Ammonia; oil-cakes, such as castor, and cotton to a less extent. Potash and Phosphoric acid are seldom applied. The average expenditure on manures is put down at Rs. 35 per acre.

The following tables selected from statistics given on pages 128, 129, 134, 135, show the increase in area and production :—

TABLE III.

YEAR.	Yield of Sugar per acre. Tons (2,240 lbs.)
1840—44	0·809
1850—54	1·163
1860—64	1·499
1878	2·231
1883	2·920
1888	3·258

TABLE IV.

YEAR.	Area of cane planted. Acres	Yield of cane per acre in tons (2,240 lbs.)	Yield of sugar obtained per acre in tons (2,240 lbs.)	Yield of sugar from cane per cent.
1894-95	195,505	30·783	3·012	.....
1899-00	220,440	33·937	3·249	9·57
1904-05	260,412	37·854	3·928	10·37
1909-10	314,335	39·033	4·033	10·33
1910-11	335,591	41·945	4·302	10·26

These figures are remarkable and everyone will feel that Mr. Geerligs is entitled to refer to them with pride. The

possibility of achieving such results is largely due to the work of the experiment stations, which were established in Java, when scientific assistance had to be called in to fight the *sereh* disease in the eighties, and which have since extended their scope into every department of sugar production.

The equipment and maintenance of Experimental Stations devoted to sugar research is, if one may so call it, a form of "Bounty" which leads to no international complications, and it is one that can give very effective assistance in building up a magnificent industry, as the Dutch in Java have proved.

The increase of production per acre seems to have been the result of (i) the knowledge that has been acquired of the manurial and cultural requirements of the soil, and the free use of imported artificial supplies of Nitrogen, and (ii) the discovery, propagation, and use, of new varieties, which can stand intensive culture, and give a large tonnage of cane, without suffering deterioration in the quality and purity of the juice

New varieties of seedling canes, produced from seed by cross-fertilisation, have been raised in Java in large numbers, propagated by cuttings, and thoroughly tested at the Experimental Stations. By this means varieties have been obtained to suit all conditions, some ripening early, some late, some suitable for heavy soils, and some for light; in fact there is sufficient choice for each grower to choose the kind best suited to his conditions, and always have a supply of ripe fresh cane ready for the mills. The old varieties cultivated before the *sereh* disease made its appearance have been almost entirely replaced by the new and superior kinds.

This work is proceeding with undiminished vigour, and great hopes are entertained of raising the yield of sugar still higher.

The cost of production of cane in Java is a matter of interest to us in India, as many conflicting statements have been made on this subject. From the data given, the net cost of cane in the field amounts to $2\frac{1}{4}$ to 3 annas per maund, without cutting and

carting charges. This figure is not less than the cost in certain parts of Bihar and Gorakhpur, but is considerably less than it can be purchased for in Rohilkhand, and the sugar tract of the United Provinces, where $4\frac{1}{2}$—5 annas is not an uncommon price.

Mr. Geerligs prefaces his description of the manufacture of sugar in Java with the following remarks :—

"The manufacture of sugar from sugar-cane in Java has attained to great perfection, and may serve as an example of a well-managed and well-controlled business. The ample investment of funds in the newest machinery, the activity of the experiment sugar stations, the adequate training of sugar chemists and factory chiefs—all these have contributed towards making the Java sugar industry a model one of which it may rightly be proud."

The table given below, taken from the figures published by the Mutual Control of Java Factories certainly supports this statement :—

TABLE V.

Java Factory Results.

YEAR.	Sucrose on 100 parts cane.	Sucrose in juice on 100 parts cane.	Sucrose extracted in juice on 100 parts sucrose in cane.	SUCROSE OBTAINED ON 100 PARTS.			SUCROSE LOST ON 100 PARTS OF CANE IN			
				Cane.	Sucrose in cane.	Sucrose in juice.	Bagasse.	Filter cake.	Molasses & undetermined.	TOTAL.
1900	12·26	11·04	90·1	9·62	78·53	87·15	1·22	0·10	1·32	2·64
1905	12·66	11·54	91·2	10·33	81·69	89·51	1·12	0·09	1·12	2·33
1910	12·54	11·43	91·2	10·26	81·82	89·76	1·11	0·10	1·07	2·28

The yields of sugar from cane are given in detail for the different residencies for 15 years on page 132. The averages for

the whole island during the years 1900, 1905 and 1910 were as follows :—

1900	...	... 9·57 per cent. sugar in cane.
1905	...	... 10·37 „ „
1910	...	... 10·33 „ „

In these statistics the yield of sugar is calculated by taking the quantity of first sugar and second sugar for the full weight, to which is added half the weight of the black stroop or sack sugar. If on 100 canes 8·39 per cent. white sugar, 0·37 per cent. refining crystals, 1·80 per cent. second sugar, and 0·38 per cent. black stroop, are yielded, the *rendement* is calculated as follows :—

White sugar ...	...	.. 8·39 = 8·39
Refining crystals	...	... 0·37 = 0·37
Second sugar ...	...	... 1·80 = 1·80
Black stroop ...	...	... 0·38 ÷ 2 = 0·19
	Total rendement ...	10·75

The kinds of sugar shipped from Java during the years 1900, 1905, 1910, are shown in the following table :—

TABLE VI.

KIND OF SUGAR.	1900.	1905.	1910.
Sack Sugar	4·7	4·4	3·1
12-14 D. S. (Polar. 96·5)	81·8	74·2	30·8
15-17 D. S. (Polar. 98·9)	11·1	10·3	30·2
18-20 D. S. and higher (sold according to sample) ...	1·9	1·2	...
Superior white sugar	·5	8·5	34·9
TOTAL	100·0	100·0	100·0

From this it appears that the Java Factories are producing year by year a finer quality sugar. In fact by studying the full table given by Mr. Geerligs on page 137, from which these

figures are taken, it will be seen that the kind of sugar has always changed rapidly to meet the requirement of fresh markets.

The prime cost of sugar in Java is given for 11-13 D. S.,—a moist, dark coloured, well crystallised, sugar polarising at 96·5—as Rs. 4-2-0 per maund. The cost of producing superior white sugar is 7·2 annas per maund, and for 18-20 D. S. 3·6 annas per maund more. The cost of producing the different grades of sugar thus works out to the following, including all expenses except interest on capital :—

Superior, White	...	... Rs. 4-9-2 per maund.
18-20 D. S.	...	... ,, 4-5-6 ,, ,,
11-13 D. S. (Pol. 96·5)...		... ,, 4-2-0 ,, ,,

Other figures are given for 11-13 D. S., varying from Rs. 4-2-0 to Rs. 4-7-0 per maund, but Mr. Geerligs thinks that those first quoted are the best.

The yield of sugar per 100 of cane for a succession of years, 1899-1910, averages over 10, from canes varying from 13·9 to 12·1 per cent. sucrose. The average efficiency factor for this period is 81·1. That is, from every 100 parts sugar in the cane 81·1 parts of sucrose are recovered. Such good work is no doubt in a large measure the result of the constant and high purity of the juice produced under the settled conditions of the Javan climate.

Comparison with Upper India.

In Upper India the indigenous canes vary to a much greater extent than is generally supposed to be the case, and are much affected by annual weather disturbances. One year they will be ripe and pure as the result of a well regulated monsoon, in another year the percentage of sugar will be considerably lower, and, what is more important, the purity may be so low as to render efficient factory work difficult. The actual percentage of sugar, and the yield of cane per acre of the indigenous varieties, as ordinarily grown by the cultivators, are also figures of an entirely different order to those obtained in Java. These facts

should be borne in mind when comparing the Javan results and prices with those obtained in India.

For instance in a district in the Eastern parts of the United Provinces in 1911 the average per cent. of sucrose in cane in 19 indigenous varieties under experiment was 10·4. In 1912, when the monsoon had been irregular in those parts, the percentage of sucrose in the same varieties was 8·28, while in the Western districts, where good conditions had obtained, 11·0 to 12·0 per cent. was not uncommon. The sugar factory is only extracting sugar from cane—it is not synthesising it from other materials, so that, however good the factory work may be, the outturn is conditioned by the quality of the raw materials at its disposal. If a factory in the Eastern districts, where the cane contained in 1911, 10·4 per cent., and in 1912, 8·28 per cent. sucrose, had been working at the high Javan efficiency given above, it could not have recovered more than 8·4 per cent. sucrose on cane in 1911, and 6·7 per cent. in 1912, while one in the Western districts could not have recovered more than 8·9—9·7 per cent.

The efficiency of large factories at work in India compares favourably with those of other countries, but it cannot be conceded, that the raw material, they have to work with, is of the same quality. The indigenous *ukh* and *ganna* varieties commonly grown, contain from 9 to 11 per cent. of sugar, varying with the season. The quality and amount of fibre is such that high extraction is by no means such an easy matter as it is with varieties like Rose Bamboo and the thick Mauritius ones.

Even where it is found that large factories can be worked with the present canes, it cannot be denied that the problem of producing white sugar, and competing with other countries, will be much easier to solve, if (i) the outturn of sugar per unit area is increased by improving and intensifying the cultivation, and (ii) if better varieties are selected with reference both to their actual sucrose content, and their workability in the factory. The writer of this review confidently believes such improvements to be possible, though they may be slowly achieved.

There is no reason why varieties should not be selected, comparing in quality with the best grown anywhere, where irrigation facilities exist. As an instance a Mauritius variety, Ashy Mauritius, may be quoted. This variety was selected from a number of imported varieties, and has been grown for some years under the best and most intensive cultivation possible. Last year it yielded under these conditions 30 tons of cane, and 101 maunds of *gur* per acre, and contained 13·05 per cent. sucrose in the canes. The local *ukh* varieties, such as *Kewahi* and *Saurati*, were only giving 30—40 maunds of *gur* per acre.

There is no reason to suppose that Java has reached the limit of its productive capacity, either as regards outturn, or acreage under cane. Wherever possible, land is being taken up, and brought under cane cultivation ; as already pointed out, the production of new varieties is proceeding apace, and careful attention to the best Agricultural methods shows no signs of diminishing.

Mauritius.

Mauritius is a considerable contributor to the imports of sugar into British India, and has this additional interest, that the field and factory work is done by Indian labourers, and that much of the cane used by the factories is grown by the thrifty Indian immigrants, who settled in the island as independent cultivators, when many of the large estates were broken up. In fact owing to the taste for emigration from India to Mauritius, that developed at an early date, the labour question there has never been acute, and this permanent complaint of most cane countries is absent.

The Mauritians, however, appear to suffer from some special complaints of their own, chiefly shortage of water, lack of irrigation facilities to use such as they do possess, and the periodic visits of cyclones, as well as cane and cattle disease. Both the large and small planters seem also to be chronic sufferers from scarcity of ready money, and their position in this respect does not seem to have been improved by the financial system of advances, that has come along with the highly appreciated Indian

immigrant. So far as one is able to judge, the Mahajan, in many guises, is very busy there.

Notwithstanding these drawbacks sugar is the one industry of the island—87 per cent. of the cultivated land is devoted to it, and the acreage and outturn has been approximately constant for some years.

The system of cane planting is interesting. The cane is planted in holes 3 feet apart in rows 3 to 4 feet from each other, and artificial manure is applied, after germination, in the form of Sulphate of Ammonia, Superphosphate, and Potash, to which dung is added afterwards if available. The growing period is 2 years in the cold regions, 18 to 20 months in the temperate zone, and little over a year in the warmer tracts, 1st, 2nd, and 3rd ratoons are taken.

Mauritius possesses several varieties of cane containing a high percentage of sucrose, 15·13—13·13 per cent. are quoted as maximum and minimum figures, and they yield a pure juice. These were introduced from various sources, Java, Trinidad, British Guiana, Queensland and Hawaii, when the older varieties began to deteriorate. The yield per acre is 2¼ tons raw sugar on the larger plantations, and 1½ tons on the smaller ones cultivated by Indians.

The raw material used by the Mauritius factory is excellent, and that doubtless has enabled them to do such good factory work, and encouraged the improvement in machinery, which appears to have been general.

The yield of sugar per 100 canes is high, as we should expect it to be, and the efficiency of the factories is increasing.

The following figures give an approximate idea of the working of the Mauritius factories :—

TABLE VII.

YEAR.	Yield on 100 cane. (Basis 96·0).	Yield on 100 sucrose in cane.
1905-06 ...	10·00	74·1
1907-08 ...	10·41	77·1
1909-10 ..	10·56	78·3
1910-11	10·63	78·5

The cane, where it is not grown by the factories themselves, is purchased in two ways :—

(i) From the large planter, who receives 6·5 to 7 per cent. of the weight of cane delivered at the factory in sugar, or the money equivalent at the current rates ; this amounts to 5·8 to 6·2 annas per maund, when the market price of sugar is Rs. 5-9-0 per maund.

(ii) It is bought directly from the Indian cultivator, who gets cash down, delivered at the factory, varying from 4·7 annas to 6·2 annas per maund, the average being 5 annas per maund.

The cost of production in Mauritius, worked out into rupees per maund, is given as follows :—

TABLE VIII.

Year.	Cost of production per maund. (Basis 96·0)
	Rs. As.
1904	5 0
1905	4 6
1906	4 2
1907	4 8

FORMOSA.

The Formosan Sugar Industry is of interest for two reasons :—

(i) The possibility of its becoming a large contributor to the Indian market, when its production is allowed to exceed the internal requirements of the Japanese Empire.

(ii) The strong measures that have been taken by the Japanese Government to extend sugar manufacture and cultivation, and the effect they have had in the short period of 10 years in laying the foundation of a gigantic industry.

Although Formosa became part of the Japanese Empire in 1895 at the conclusion of the Chino-Japanese war, it was not until 1900 that the development of the country could be taken in hand seriously by the new owners. One of the first things to receive their attention was the sugar industry, already important but in a very backward state both as regards cultivation and manufacture. In 1902, a Sugar Bureau was established to deal with all questions of sugar production, and this organisation at once began a vigorous campaign. Japanese students were sent to Java and Hawaii to try to learn the best methods employed there, and efforts were at once made to replace the two very inferior varieties of cane that Formosa possessed at the time, by varieties possessing a higher sugar content. The well-known canes of every country were imported, and severely tested at the experiment stations in many parts of the island, in the hope of finding one suited to Formosan conditions. Hawaii, Java, Mauritius, and the West Indies, all contributed their best varieties and seedlings; and the Sugar Bureau have had no difficulty, apparently, in deciding that *Rose Bamboo*, obtained from Hawaii, is the ideal cane for Formosa.

Having decided on this, measures were taken to extend its cultivation. Wherever it was planted, manure to the value of Rs. 12 per acre was provided free by Government, on condition that growers expended Rs. 16 per acre for the same purpose. At the present time, 75 per cent. of the area devoted to cane is under this variety. The outturn per acre has been increased from 8 tons of cane with a yield of 6 per cent. of inferior raw sugar, given by the indigenous varieties, to 14 tons cane per acre with a yield of 11 per cent. centrifugalled sugar where *Rose Bamboo* has been taken up.

This extension was not, however, due to educational propaganda alone. The Sugar Bureau, when they had reason to

believe that the reforms and improvements suggested by them were not meeting with ready response at the hands of the cane growers, passed an ordinance in 1905, which included amongst its terms the following :—

(i) No sugar factory can be started without the sanction of the Director of the Sugar Bureau.

(ii) The area within which cane can be purchased by any factory is defined, and another factory cannot be started in that area.

(iii) Cane grown in the defined area must be sold to the factory, and not exported to another area.

(iv) The factory is bound to buy all the cane grown in its area whether it needs it or not, but growers are under no compulsion to plant cane.

(v) Cane cannot be crushed in small bullock mills without permission, which is not freely given.

Sugar became a licensed trade in Formosa as a result of these regulations: and £2,500,000 already paid up capital is invested in the production of sugar by modern methods. There are 29 big factories at work, crushing from 500 to 1,000 tons of cane a day.

The price paid for cane has not gone down. Cultivators, as pointed out, are not compelled to plant cane, but if they do, they must sell it to certain factories. The price, moreover, has to be approved by Government. The price of cane at present works out to about $4\frac{1}{2}$ annas per maund delivered at the factory. The cost price of sugar at the factory is Rs. 4-$8\frac{1}{2}$ per maund. The sugar produced appears to be a fine grained moist sugar made specially to meet the requirements of the Japanese market, but with the modern plant possessed by the factories they could produce any kind of sugar.

Details of the working of a single Formosa Sugar Factory taken from a paper* on the Formosan Sugar Industry are given below.

TABLE IX.

YEAR.	Sucrose on 100 parts cane.	Sucrose in juice on 100 parts cane.	Sucrose extracted in juice on 100 parts sucrose in cane.	SUCROSE OBTAINED IN 100 PARTS.			SUCROSE LOST ON 100 PARTS CANE IN			TOTAL.
				Cane.	Sucrose in cane.	Sucrose in sucrose juice.	Bagasse.	Filter cake.	Molasses and undeterminied.	
1908-09 ...	13·9	12·16	87·5	10·61	76·3	87·2	1·71	·18	1·55	3·17
1909-10 ...	13·4	12·28	91·7	10·7	80·0	87·1	1·00	·11	1·58	2·39
1910-11 ...	13·1	11·97	91·4	10·23	83·0	90·0	1·13	·11	1·74	2·98

This shows an exceedingly high state of efficiency, as high, in fact, as given in Mr. Geerligs' book for the Javan results.

The actual amount of raw sugar produced during this period is given as follows :—

1908-09	...	.. 11·22 per cent. on cane.
1909-10	...	... 11·38 ,, ,,
1910-11	...	... 10·88 ,, ,,

An idea of the increase in the Formosan Industry can be gathered from the exports, which are as follows :—

1901-02	...	...	... 46,893 tons
1904-05	...	...	... 49,565 ,,
1907-08	...	...	... 68,450 ,,
1908-09	...	...	... 122,000 ,,
1909-10	...	...	... 160,000 ,,
1910-11	...	...	... 256,950 ,,

Mr. Geerligs points out that the success of the Formosan Industry is due to the powerful patronage of the Japanese Government, and that whether the export to foreign countries develops depends entirely on the inland politics of Japan. With our past experience of what bounty-fed sugar can do in

the way of cheap exports, the situation is worth careful watching from the point of view of the Indian market.

PHILIPPINES.

The sugar industry of the Philippines is of interest mainly on account of its possibilities in the near future, when American capital and enterprise have had time to develop the natural advantages that these islands possess for cane cultivation. The extent of the latter may be judged from the fact that, in spite of primitive methods of cultivation and extraction, and an open pan system of evaporation, the industry has always been considerable. In 1911, 207,219 tons of a low grade sugar (Polar 89·0) were produced, and exported at a profit.

When attention is paid to improving the cultivation and quality of the cane, and when the old methods of manufacture are replaced by modern ones, it is easy to imagine that a great development may take place.

Encouraged by the protection of the United States, American capitalists have turned their attention to the Philippines. In 1909, 50,000 acres were secured by American Sugar Syndicates in Mindoro, and more recently 20,000 have been taken for sugar cultivation by Hawaiian planters in another island.

How far the progress of the Sugar Industry will be influenced by the new American Tariff it is difficult to say, but, should it be anything like that indicated, it is reasonable to suppose that the Indian market will receive attention. Mr. Geerligs' remarks on the future of the industry in the Philippines are significant. He says: "It may have in the end a future such as we dare not put down in words."

GENERAL.

Most valuable and interesting information from different countries is given on the following points:—

(i) The price of cane.
(ii) The outturn of sugar per 100 cane.
(iii) The yield of sugar per acre.

Some of these results have been selected, and summarised in the following table :—

TABLE X.

Country.	Price of cane delivered at factory, annas per maund.	Yield of sugar per 100 cane (Basis 96 Polar.)	Sucrose per 100 cane.	Yield of raw sugar per acre in maunds.
Cuba ...	4·4	11·62	12·13	53·5
Hawaii ...	5·8	12·50	15·8 - 17·8	127·5
Australia ...	6·0	10·95	12·13	51·6
Brazil ...	1·6·5	9·0	15·0	51·1
		(5·6 open pan)		
Egypt ...	5·5	10·71	12·73	58·0
Barbados ...	.....	7·5 (Muscovado)	13·5	.....
Trinidad ...	.....	8·94	12·5	.....
British Guiana ...	3·0	8·1	11·5	.....

It will be noticed that the price of cane in Cuba is not high in spite of the scarcity of labour. This is accounted for by the fact that cane, when once planted, yields a large number of ratoon crops (five or even more). The price in Hawaii is high due to labour difficulties, which seem to be more prominent here than in most countries. Indentured labour is of course forbidden by the United States, and white labour finds it hard to stand the strain of field work under tropical conditions. Everything has been tried; Portuguese, Japanese, Russians from Vladivostock—but the labour question is still the limiting factor in Hawaiian production.

The scarcity and high price of labour is compensated, to some extent, by the high outturn of sugar per acre, and the efficiency with which the factories are worked. The sugar content of the bagasse is reduced to 3 per cent., and the extraction of sugar per

100 sugar in the cane reaches 95 per cent. This result is produced by maceration to an extent which would not be profitable in a country like India, where labour is plentiful and fuel scarce. The yield of raw sugar per acre in Hawaii also exceeds that of any other country. The average for 1910 over the whole island was over $4\frac{1}{2}$ tons; while on selected estates it was as high as 8·8 tons. Careful attention is given to cultivation and the selection of suitable varieties, and the cane fields are intensely manured. The amount spent on artificial manures (Sulphate of Ammonia, Saltpetre, Potash and Superphosphate) is given as Rs. 60 per acre.

No cane-growing country has been overlooked by Mr. Geerligs; from Cuba, with its two million tons, to Tahiti in the Society Islands, with an annual production of 400—500 tons. The information obtainable is naturally more complete in some countries than in others, and most complete of all where systems of mutual control have been established.

If it is permissible to offer a suggestion for the improvement of so excellent a volume, it might be said that, in a new edition, a little more information with regard to the working of the central factory system in the West Indies would be welcome to East Indian readers.

SOME IMPROVEMENTS IN THE PACKING AND TRANSPORT OF FRUIT IN INDIA.

BY

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I.—Introduction.

In this paper it is proposed to deal briefly with the packing and transport of fruit in India, and to draw attention to some of the improvements which can be made, at once, in the present methods of dealing with this trade. In several tracts of India, particularly on the Western Frontier, excellent fruit can be produced; while in large cities, like Calcutta, Bombay, and Delhi, markets exist for the produce. In addition to the large towns and Military cantonments, a number of European and Indian consumers are to be found, scattered through the country, who are ready to purchase fruit, provided it is good, fairly cheap, and properly packed.

The general conditions under which fruit is grown and transported in India must be borne in mind. The methods of production are primitive compared with those of other countries in which cultivation has been taken up on modern lines. The crops obtained by the people per unit of area fall below what is easily

possible, both in quantity and quality. This result, in a vegetarian country, can only arise from a low standard of agriculture. The packing and transport of the produce to the railway are equally primitive. In consequence, a great deal of loss and damage occur in transit, and the distance to which fruit can be sent by the present methods is comparatively short, especially as most of the produce has to be carried through hot regions where the humidity is frequently very high. These causes seriously limit the market open to any fruit tract, and diminish the number of possible customers.

In the production and transport of fruit in India great improvements can be made. Experience in the plains, at Pusa in Bihar, and at Quetta on the Western Frontier, not only in the cultivation but also in the packing and transport of fruit, has shown quite clearly what an enormous amount of progress is possible. The results already obtained prove that it is neither the soil or climate, nor the varieties grown, that are at fault, but that the poor results obtained by the people are the direct consequences of the primitive methods of agriculture in vogue. It is sometimes thought that little or nothing can be done to develop the Indian fruit trade unless the Railway Companies construct refrigerator cars, and until cold storage facilities at the large markets are provided. Experience indicates that a great field for development is open without these expensive means of transport and storage, and that the road to success lies rather in the direction of better methods of production and packing.

II.—The Present Methods of Packing Fruit.

In order to appreciate the present condition of the Indian fruit trade, it is necessary to follow the produce from the garden to the market.

There is a great similarity, in different tracts, in the methods of picking fruit for market. In order to withstand the rough handling experienced at all stages in the processes of marketing, fruit, of all kinds, is always picked green and unripe, and at a stage when the full development of flavour is impossible. The

want of attention to pruning, and the close planting of the trees, render the damage in picking much greater than would be the case in modern fruit gardens, where dwarf trees are the rule. The crop is often shaken off the branches, either into sheets or else on to the ground. A good deal more bruising takes place when the fruit is heaped up before packing. Padded trays for picking are unknown, and the grading and packing are done on the ground, generally under the shade of a tree. There are no packing sheds, and no padded packing tables—possibly on account of the national custom, of working, as far as possible, on the ground.

The packages used for fruit, even for such delicate produce as grapes and peaches, are for the most part ill adapted for the purpose. Old kerosine oil boxes represent the rigid type of fruit box, while wicker baskets of various sizes and shapes are common. There is a general absence of ventilation, in all the packages—a circumstance which probably follows from the necessity of covering in the fruit to prevent theft. The packing material used is often unsuitable, grass and leaves being commonly employed; these give off water and do not absorb the moisture transpired by the fruit; in consequence, fermentation and decay are hastened. The flavour is often harmed by the want of ventilation, and the fruit sometimes becomes tainted. There are other disadvantages from the packages used; the upper layers of fruit press on the lower and a good deal of crushing and bruising take place; the packages are often non-rigid and are crushed out of shape, in transit, by the weight of others above them. Good examples of this crushing are to be seen on the Jhelum valley road in September when the Kashmir apple crop is on the way to the Indian market.

The facilities for carrying fruit on some of the Indian railways are excellent. Well ventilated fruit vans, constructed to run on the mail trains, are in use on the North-Western Railway and also on the East Indian system. The North-Western vans are provided with shelves, and through cars are provided on certain sections of the line. The material carried by these vans,

however, leaves much to be desired. The fruit is often spoiled, or at least greatly damaged, before it is loaded on to the trains; the packages are of all shapes, sizes, and weights, and there is a great deal of loss of shelf room and van space. The circular wicker packages are bound to rock in transit, and some shifting is bound to take place on steep gradients, and round curves. Some of the wicker baskets are too heavy for the coolies to lift easily, and these are often rolled out of the vans, on to the platforms, at large junctions where the contents of the vans have to be distributed.

In the markets themselves a good deal of further damage results, although most of the large cities provide roofed-in markets and numerous fruit stalls. The national custom, of doing everything on the floor, again asserts itself and, before the contents of the fruit packages are displayed for sale, a preliminary sorting over, on the ground, to remove the worst casualties, is a common spectacle. The sale of fruit is usually by weight, and in this process and in the subsequent transport to the table, often by means of a *jharan* (duster), the last series of bruises are inflicted. There is little wonder, therefore, that the final product presents a battered and bruised appearance, and that good fruit is so rarely seen in India.

III.—Experiments on the Packing of Fruit in India.

A considerable amount of attention has been paid to the packing of fruit under Indian conditions, both at Pusa in Bihar and also at Quetta. These experiments were originally started in 1908, at Pusa, and have been continued since, as opportunity offered, particularly at Quetta during the summers of 1911 and 1912.

Bamboo peach baskets.

The first of these experiments related to the packing of Bihar peaches, in 1908 and 1909. In this tract, peaches ripen towards the end of May and the beginning of June, when both the day and night temperatures are high. The air is frequently

damp at this time, so that the conditions for transporting such delicate produce as peaches are particularly exacting. In 1909, a method of packing was devised and tested, by which practically ripe peaches could withstand a journey of 72 hours on the railway, without deterioration, when booked in the ordinary way. Local materials and labour, only, were used in the work, and no artificial cooling was employed at any stage. The packages adopted were round, flat-bottomed, bamboo baskets, about 5½ inches high, fitted with flat lids. Into these, two tiers of small, circular, bamboo cells, for the single selected peaches, were fitted; the two tiers being separated by a flat, circular, open-work, bamboo partition which could be dropped into the basket to serve as a floor for the second tier of cups (Fig. 1). The lid, when wired on, served to secure the upper tier, and also to keep the whole basket, and its contents, rigid. Theft was prevented by sealing the wire by means of a lead seal, in the manner adopted in the Kulu apple baskets when sent by parcel post. Each basket contained about 25 bamboo cups, and thus served to carry that number of peaches. These baskets were made by the local *domes*, for four annas each. If required in large numbers the contract price would be considerably less than this.

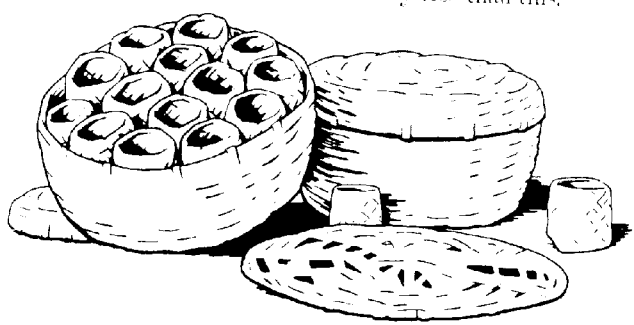

FIG. 1.—BAMBOO PEACH BASKETS.

Picking is best done at daybreak, as at this time the temperature is near the minimum, and the peaches are relatively cool. They are best picked, one layer deep, into trays or baskets padded with *san*, and the wrapping in thin blue paper is done on

padded tables in the plot. A little *san* fibre, covered with gunny, provides a good padding on a table for packing purposes. Only the best peaches are selected, which, after wrapping, are packed into the cells, with a little *san* fibre to prevent shaking and bruising during transit. The *san* should be wrapped round each fruit, and the whole should fit well into the cell, without any shaking. The paper and *san* fibre, besides, absorb part of the moisture given off by the peaches during the journey, while the openwork nature of the package promotes ventilation. Other materials for packing, besides *san*, were tried, such as peat, cotton wool and wood wool. None of these proved so cheap or so resilient as *san*. Sent in this manner, peaches reached Simla in excellent condition, and withstood the journey of three days. This transport involved a journey of seven miles in a bullock cart to the railway, the crossing of the Ganges in a ferry steamer, and eight changes between the garden and destination. Attention is drawn to these results as they show what can be done in India in the transport of fruit, with no other materials and labour than are available, and without the use of ice cars. All that is necessary is proper care in picking and packing and the use of suitable baskets. Some difficulty is always experienced in training the local labour to pick properly and to take sufficient care in handling the fruit. Boys are best for this work, and after a time they learn to judge the right stage at which peaches should be picked. Their general tendency is to pick when much too unripe.

Venesta-wood fruit boxes.

The next step in the fruit packing experiments consisted in the trial of returnable fruit boxes at Quetta, in 1911. This work was undertaken after seeing the way in which the fruit vans were loaded at Quetta. These ventilated cars have been constructed so as to run at high speeds, and can be attached to the mail trains. The fruit is carried mainly on shelves running down the sides of the van, and the miscellaneous packages, all shapes and sizes, which are placed on these, involve a vast loss of carrying

capacity, and lead to a good deal of movement in transit. It appeared that if a returnable outer package, constructed to fit the shelves, could be devised, this loss of shelf room could be avoided. This was pointed out to the Local Administration in 1909, and some correspondence on the subject ensued between the Political Officers at Quetta and the North-Western Railway Company. The result was that a concession was obtained, by which the senders of fruit boxes of standard size were granted the free return of empties on the North-Western system. Accordingly, a returnable fruit box, made of venesta wood and fitted with cells made of the leaves of a dwarf palm known as *pish* (*Nannorhops Ritchieana*) found growing in the lower valleys of Baluchistan, was, in 1910, modelled on the bamboo peach baskets by Captain Keyes, I.A., then Assistant Political Agent at Quetta. A number of these boxes were tried in 1911, one of the objects of the experiments being to see how far returnable fruit packages could be used with success under Indian conditions. These returnable venesta boxes with *pish* cells did not prove successful, and were not taken up by the local fruit merchants. The *pish* cells were very irregular in size and, in consequence, the labour of packing was considerable. They were uneven in shape and size, and had no reference either to the size of a peach or to the dimensions of the boxes. A large amount of time was therefore wasted in adapting these cups to the purpose in view; although they appeared to be cheap, in reality they were very dear, on account of the extra time and labour in packing and the large number that had to be thrown away. The frequent contraction of the rim of these units rendered the removal of the peaches on arrival a difficult matter. Further, the venesta boxes were not rigid enough and when filled with peaches the sides bulged and so the sliding lids were difficult to adjust—moreover, there were no floors to separate the different layers. The boxes, when filled, usually weighed from fourteen to fifteen seers, and thus came midway between the ten and twenty seer rates; each box was therefore charged for as twenty seers. These disadvantages were small, however, compared with the mistakes and overcharges

made by distant Railway Companies when the empty boxes were returned to Quetta. Frequently they were charged for at full parcel rates, the charges sometimes being equal to the first cost of the boxes. The only remedy for these mistakes was to pay the charges and then to file a claim. Our experiences with these boxes in 1911 showed that, under the present railway rules, any merchant sending large numbers of returnable packages on the Indian railways would have to keep at least one extra clerk to file claims and to conduct the additional correspondence that would ensue with the Railway Company.

Non-returnable fruit packages.

In 1912, it was decided to work largely in the direction of light, non-returnable packages, and to avoid altogether the difficulties connected with the return of empties. In these investigations the observations and enquiries made while on deputation in England in 1910, on the methods of packing and transporting fruit to the London market, were of considerable assistance. Attention was paid not only to the British fruit trade, but also to the manner in which fruit is sent from the Continent and other countries to the Home markets. It was found that there was a growing tendency, in Great Britain, to copy the cheap non-returnable gift packages, of the Climax type, now such a feature of fruit transport in the United States. These are made chiefly of *chip* and are exceedingly light, cheap, and attractive : particularly for delicate fruit such as strawberries. Arrangements were at once made with the British Basket Co. of Glasgow, the manufacturers of these packages in Great Britain, to import a number for trial at Quetta under Indian conditions. It was soon discovered, however, that these boxes, although sound in principle, were quite unsuited to India, on account of the railway rules in force, by which each package is charged for, separately, according to a scale of weights. For example, any package between ten and twenty seers is charged as twenty seers. It was evident that the packages would have to be made to fit the rates, and accordingly all those likely to be

of use were redesigned. A number of each were made to order for the Quetta experiments, and in this a large amount of valuable assistance was given by the manufacturers. After some preliminary trials in 1911, the following packages were designed, which were again tested in 1912 and then put on the market at Quetta :—

1. Peach crates, with chip compartments, to come under the five-seer rate.
2. Grape boxes for small consignments.
3. Various forms of Climax baskets for local use.
4. Non-returnable crates for the wholesale trade
5. Returnable crates, for short journeys on the North Western Railway and for carrying fruit on camels.

Peach crates.—There is a market, in Baluchistan, for a light, non-returnable, fruit crate, suitable for choice peaches and nectarines, which would come under the five-seer rate. Two crates, each weighing 1 seer 2 chittacks, were designed for this purpose, one to take fifteen large peaches, the other to take twenty medium sized fruits. The principle in each was the same, namely, the provision of a separate chip compartment, with a lid, for each peach—the whole to be carried in a light, ventilated crate. Three and a half inch cube compartments were used for the fifteen size, while three-inch cubes were employed for the crate with twenty compartments. The separate compartments are made of chip, which is prepared at Glasgow for bending into the cubes, and packed flat in suitable lengths for transport to India. Each cube is made of two pieces of chip, and these can be sewed together either by means of a wire stitching machine worked by the feet or by a hand automatic stapling press such as is used for fastening papers. The peach crates are packed in the same way as the bamboo cells of the Pusa peach baskets. Each selected peach is wrapped in thin paper, and then in a little *san* fibre—the whole being placed in the compartment so that there is no movement in any direction. The upper laths are then nailed on, and the crates secured by means of string or wire and sealed with a lead seal, in the manner indicated in

Fig. 2. In securing with string it is best to cut a small groove at the corners, so as to prevent slipping.

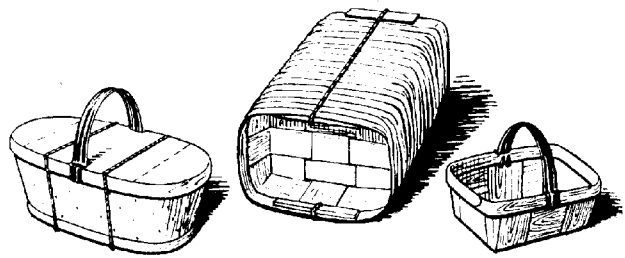

FIG. 2.—PEACH CRATES USED AT QUETTA IN 1912.

One great advantage of these peach crates should be noticed. The compartments are machine-made, and fit the outer crate accurately. As they are square, and not round, packing is facilitated, and the time taken in the work is shortened. This uniformity in machine-made units will always be a great advantage over locally made round cells of *pish*, or bamboo, which never quite fit. These peach crates are exceedingly strong, and bear railway transport without damage. About 1,200 of these packages were sold at Quetta in 1912, largely to Indian fruit merchants. They were put on the market complete, including *san* fibre, wrapping paper, and a sheet of printed directions in Urdu and English—and were sold at nine annas each.

2. *Grape boxes.*—It was proposed to try experiments in 1912, at Quetta, with small wooden grape boxes—using cork dust as the packing material. The cork dust, however, did not arrive in time and the original experiments could not be carried out. The boxes were however tried, with *san* fibre as packing material and proved successful—the complete stock of the larger size which measured $15 \times 7 \times 4\frac{3}{4}$ inches and which weighed 10 chittaks each, being sold at once. When packed for long distances the bunches of grapes should be wrapped in thin paper and packed a little time after picking, so as to allow the stalks to wither. The packing must be rigid, and this is possible by the use of *san* fibre. These grape boxes are clean and light and, where wood is

scarce and labour dear, as at Quetta, can be put on the market cheaper than locally made boxes. The original experiments using cork dust as a packing material—will be carried out next year. These grape boxes were sold retail at Quetta at three annas and a half each.

3. *Climax baskets.*—In order to supply cheap fruit baskets, both for use in markets and also in fruit gardens, a number of different kinds of Climax baskets were imported from Glasgow. These are sent out, nested, with the metal handles separate. They were put on the market, at Quetta, and sold at six, eight, and ten pice each, according to the size. These baskets (Fig. 3) are exceedingly neat and clean, and are much more attractive than the ordinary tamarisk baskets available in fruit gardens at Quetta, which cost about the same. They can also be used for taking fruit for railway journeys, and for this purpose might find a ready sale on the Indian railways. They are so cheap that they can be thrown away after the journey. On account of thefts in transport Climax baskets cannot, of course, be used for sending fruit by train, as in the case of the strawberry trade in England.

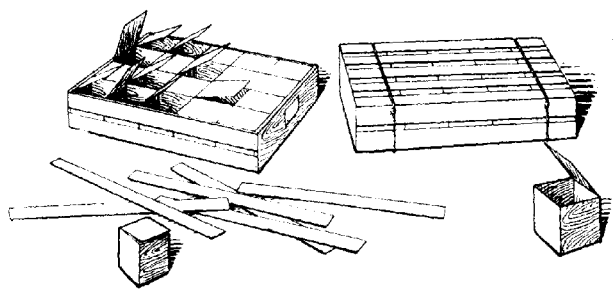

FIG. 3.—CLIMAX FRUIT BASKETS.

4. *Non-returnable crates.*—For the wholesale fruit trade in India there is no doubt that a suitable non-returnable crate is greatly needed at the present time. Some attention has therefore been paid to this matter during the past two years. As a result, a cheap, light, non-returnable crate, holding 24 punnets,

has been designed, tested, and put on the market. By this means, tomatoes, grapes, and peaches were successfully sent from Quetta to Calcutta, in 1912, without loss or damage in transit. The distance is approximately 1,750 miles and the journey takes about four days. The consignments had to withstand not only the dry heat of the desert as far as Delhi, but also the high temperature and high humidity of the monsoon period on the journey through the Gangetic plain.

For long journeys, non-returnable fruit packages must be strong, light, and cheap, and there must be good ventilation; they should be as attractive as possible and should look clean and fresh; the weight when filled should not be too great, and the cases should be easily handled by the railway staff; the package should be capable of being closed, rapidly, in such a manner as to make thefts in transit exceedingly difficult; the fruit must be packed sufficiently tightly to prevent any movement in transit, and the upper layers must not press on the lower; further, the boxes must be able to travel equally well in any direction. These conditions were fulfilled by the use of the non-returnable crates illustrated in Fig. 4.

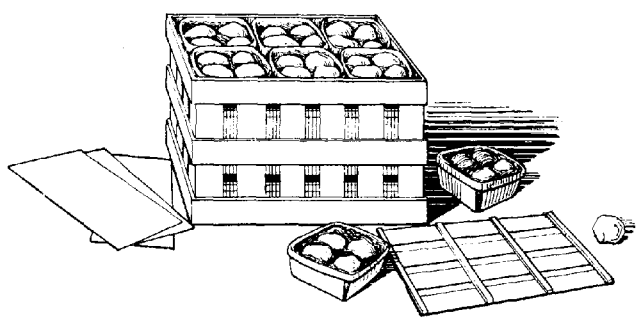

FIG. 4.—A NON-RETURNABLE CRATE.

These crates, which measure $24 \times 16 \times 13\frac{1}{2}$ inches and weigh $5\frac{3}{4}$ seers, contain 24 punnets, each $7\frac{1}{2} \times 7\frac{1}{2} \times 3$ inches, arranged in four layers separated by floors. Six of the punnets exactly fit the crate, and a light floor, made of laths and fixed together

with cross pieces, rests evenly on the edges of the punnets below. In this way the weight of the upper layers is supported without injury to the fruit. The cross pieces tend to keep the punnets in place and prevent lateral movement. The crate is closed by nailing on the thin boards, and a wire is passed lengthwise round the box, through the corners, and finally sealed with a lead seal: theft in transit is thus rendered practically impossible. The weight of the crate, when filled with fruit like tomatoes, is about 29 seers, so that it comes just under the 30-seer rate. These crates complete were placed on the market, at Quetta, in 1912, and sold at the rate of two rupees each.

In packing these crates several matters require attention. The fruit should be carefully picked in the early morning, when cold, into padded trays or baskets, and the grading and packing should be done on padded tables, in the shade, so as to prevent bruising. Delicate fruits, such as peaches, nectarines, grapes, and tomatoes, should always be wrapped in thin paper before packing. This not only prevents damage, but also delays the rise in temperature of the fruit, on the journey through India.

It is found that consignments of cold, wrapped fruit heat up very slowly—compared with non-wrapped parcels packed in the ordinary way. Wrapping checks the ripening processes, on the journey, and lengthens the life of the produce. In this matter Baluchistan possesses a natural advantage over its competitors in the fruit trade, as all the benefits of precooling before transport can be obtained *for nothing*.

The packing of the punnets should be firm enough to prevent any movement in transit and, for this purpose, some cool, resilient packing material—like *san* fibre—is a great advantage.

The system of separate punnets, packed in one crate, enables mixed consignments of fruits to be made up without difficulty. By this means these non-returnable crates can be used for other purposes as well as for the wholesale trade. Private customers, while unable to use a crate of any particular fruit, might easily take crates containing five or six different

kinds of fruit and several sorts of out of season vegetables in addition—such as peas and beans, which are not seen in India during July, August and September. In 1912, several mixed consignments of peaches, plums, grapes, tomatoes—as well as peas and beans—were sent from Quetta to Calcutta and Simla. Several of the Quetta fruit dealers are considering how they can make use of these mixed consignments in extending their business with India.

One further advantage of this method of packing should be mentioned. This relates to the ease in marketing when fruit is sent in units. These small packages save an enormous amount of time in unpacking and selling when the market is reached. There is no rehandling and sorting of the fruit; each unit is ready for sale; and the punnet serves as a clean and attractive gift package in which the produce can be taken away without trouble or damage.

The way in which fruit is exposed for sale is an important part of the business, and the more attractive the unit the better. There seems no reason why this method of sale should not be taken up widely in the various Indian markets. The units can be arranged easily on the present fruit stalls, and, even if sold by weight, the package and its contents can easily be weighed together. If such a system is adopted, there is no doubt that a great reform in the present methods of marketing will have been made.

Returnable crates.

For short journeys on the North-Western Railway—such as Quetta to Karachi or Quetta to Lahore—returnable crates, on the same principle as the non-returnables, were designed. Each contains 24 punnets, in four layers, but the crates are fitted with hinged lids, and can be closed by means of padlocks. They are iron bound at the corners, and are strongly made so as to withstand frequent journeys by train or on camels, to places like Ziarat. It is possible they may be taken up for the Kandahar fruit which is now packed in wicker baskets and sent on donkeys to the railway at Chaman. For railway transport their use

will probably become general as soon as the rules and rates for returned empties are made uniform on the Indian railways.

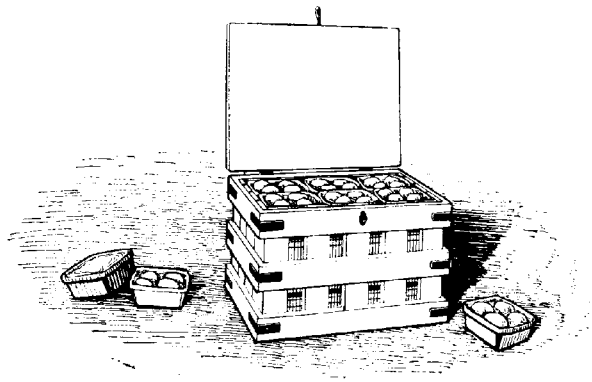

FIG. 5.—A RETURNABLE CRATE.

The cost of the above non-returnable packages must now be considered. The rates charged by the manufacturers, in 1912, were as follows. (In all cases except when otherwise specified, the figures quoted are rupees per gross)—

1. Peach crates, twenty size, Rs. 15-8.
2. Peach crates, fifteen size, Rs. 15-8.
3. Material for 3″ cubes, Re. 1-2.
4. Material for $3\frac{1}{2}$″ cubes, Re. 1-5.
5. Non-returnable crates per dozen, Rs. 5-10.
6. Grape boxes, large size, Rs. 15.
7. Climax baskets with covers, large size, Rs. 14-10.
8. Two-pound punnets for the non-returnable crates, Rs. 4.

The prices naturally vary a little with the value of wood, but the above represent roughly the cost of these packages, at Glasgow, in 1912. Packing, ocean freight and other charges would of course be additional. In the Quetta consignment of 1912 these extra charges—including packing, freight, agents' fees at Karachi (which are very high), customs duty at the port, octroi at Quetta, and railway freight—came to fifty-five per cent. of the original cost. These expenses, however, could probably be

reduced in the case of larger consignments ordered in the regular course of business. One of the chief items was agency fees at the port, which would be saved in the case of consignments ordered by Bombay and Calcutta dealers.

The *san* fibre used in the experiments was obtained in pressed bales from dealers in Oudh, and cost Rs. 4 per maund, while the automatic stapling machines, for putting together the peach cubes, were supplied by the Army and Navy Stores, Bombay, for Rs. 3-12 each. The cost of the staples was one rupee a thousand. For work on the large scale a wire stitching machine would probably be cheaper than these hand stapling presses.

IV.—The Marketing of Fruit in India.

The disposal of the produce.

The present system of disposing of the fruit crop in Baluchistan is not very advanced. The usual method is for the *malik* to sell the year's crop of any garden to a fruit merchant, often a Hindu, for a lump sum—the picking and packing being done by the dealer. Some of the produce is sold locally, and the prices charged in the Quetta fruit market are, on the whole, exceedingly high. The rest of the fruit is sent to India, a large portion being consigned to agents in the Crawford market in Bombay. These agents are said to be unreliable and to give good prices at the beginning of each season, but practically nothing for later consignments. It is commonly supposed that they form rings for the purpose of reducing the price to the senders of consignments, and that they generally regulate the market for their own benefit. If these statements are true, it is obvious that this state of things stands in the way of progress, and that some reform is necessary in order to enable the grower to obtain a fair share of the profits of his labour.

The growers and local dealers can be assisted in their business in three ways. In the first place, they should take steps to obtain official statements of the retail prices of their produce,

charged to customers, in the large markets in India. Such statements are issued to the press in cities like Calcutta and Bombay, where the markets are under efficient Market Superintendents. It would not be a difficult matter to have these statements disseminated in the chief centres of fruit production. A knowledge of these prices would naturally help those interested in the fruit trade to cope with their agents at Bombay and other centres.

The second line of advance in this matter would be an efficient method of auctioning fruit at markets like Calcutta and Bombay. These auctions would have to be conducted under the supervision of the Market Superintendents, and the growers would have to be prepared to take their produce off the market in case the dealers attempted to form a ring for the purpose of controlling the market. This method of disposal was suggested by the Market Superintendent at Calcutta, and there appear to be no real obstacles in the way.

The third and perhaps most important way of helping the trade would be to establish agencies in the chief markets, under European supervision, which would be outside any rings made by the Indian dealers. An experiment is in progress, in this direction, in Calcutta, where the Great Eastern Hotel Company proposes to rent a fruit stall in the New Market, during 1914, for the sale of Quetta fruit and vegetables sent from the Experiment Station. The produce will be exposed for sale in the unit gift packages referred to on pages 256-7, and every effort will be made to place superior fruit and vegetables before the consumers. In this experiment the co-operation of the Deputy Chairman of the Calcutta Corporation, and of the Market Superintendent, has been obtained, as well as the active interest of the Great Eastern Hotel Company.

Refrigeration and Cold Storage.

The recent advances in the methods of artificially cooling fruit before and during transport on the railways of the United States, and the spread of cold storage facilities at the principal markets in that country, have drawn attention to the possibility

of utilising these devices in India. Perishable fruits like peaches are now precooled before loading, and then sent, in refrigerator cars, from the orchards of California to the markets of the Eastern States. The cold storage warehouses, in which meat and fish are stored for long periods, are also used for apples and similar fruit. At first sight there seems no reason why these methods should not be adopted immediately in India, and the problems of the successful transport and storage of perishable products like fruit instantly solved by simply copying what has already been done in California.

The conditions of the fruit industry in the United States are, however, quite different from those in India. In California, Georgia, and other important centres, fruit is grown, to perfection, in vast quantities, and it is possible to fill whole vans—and whole trains—in or near the orchards, and to erect all the cooling plant necessary. In the Eastern States, large cities exist where well-to-do purchasers abound, who do not mind paying high prices for fruit offered in an attractive manner. In India, the conditions are altogether different; the quality of the fruit at present produced is relatively poor, and the amount is small: the methods of packing are primitive, and merchants do not exist who are capable of handling the business in a large way; further, there are no markets for fruit in India comparable with those of the United States; the number of Europeans in the plains during the monsoon period falls to a minimum, and they are quite unable to pay high prices for fruit, although they are willing to buy it if it is good and fairly cheap.

In 1911, and again in 1912, some first hand experience was obtained relating to the prices likely to be obtained in India for good fruit, properly packed. A large number of packages of Quetta fruit were sent for sale to clubs, hotels, shops, and to various private individuals, as well as to Indian fruit dealers in the large cities. The fruit was sold for the highest prices obtainable, and in this way a fairly accurate idea of the possibilities of the Indian market was obtained. In addition, visits were paid to the public markets of cities like Bombay, Calcutta

and Lahore, where the Market Superintendents and various Indian dealers were interviewed. The result of these experiments and enquiries was to show that there is a considerable demand for good, well packed fruit, at moderate prices: but there is hardly any demand for fruit, however excellent, at what may be described as really high prices. In the larger markets, the methods of handling fruit are still primitive, and a great deal remains to be done before even Calcutta will be in a position to handle van loads of fruit sent by refrigerator cars. Further, between the fruit growing areas of the North-West Frontier, and Calcutta and Bombay, there are no large cities which could dispose of van loads of cooled fruit at prices likely to be remunerative. A consideration of all the circumstances of the present fruit industry in India, therefore, discloses the fact that there is no immediate prospect of success for refrigerator cars on the Indian railways. It is possible, however, that, in the future, there may be a demand for this class of transport. This will depend mainly on the needs of the Indian section of the population. If a great demand for the fruits of the North-West arises from the people themselves, and if they prove willing to give prices that would pay for cool transport, then it would be easily possible to meet these demands and to follow the lead of California. At present this demand does not exist, and the Indian population seems satisfied with semi-tropical fruit like bananas, mangoes, and guavas, which can be transported by the present methods, provided this produce is picked sufficiently unripe.

Improved Railway Facilities.

Speaking generally, the present railway facilities in India are in advance of the fruit merchants, whose methods of packing are primitive in the extreme. On several railways excellent fruit vans with good ventilation have been provided, for use in connection with the mail trains. At the same time several railway reforms relating to rates and regulations are urgently called for. One of the consequences of the large number of

Railway Companies in India is the want of uniformity in the rules relating to the transport of fruit and the return of the empty packages to the sender.

One direction in which the Railway Companies can help the fruit trade is in weighing and booking a number of packages together, when sent to one consignee. On many railways, each package is now weighed separately and charged for at the next highest point on the scale. Thus ten crates, each weighing 28 seers, would be charged for as ten 30-seer parcels and not as seven maunds. This concession—of charging for fruit on the collective weight of the consignment—could easily be granted to the users of packages of standard size and pattern like those referred to in this paper; the cost to the Company would be more than repaid by the increased carrying power of their vans and the greater ease in dealing with the traffic; it would act as an inducement to merchants to use standard boxes, and would lead the way to whole van consignments to one market. This concession is already in force, to a limited extent, on both the East Indian Railway and on the Bengal & North-Western Railway. It only requires to be made uniform and universal in India, for the improved fruit packages.

Another direction of progress relates to the return of empty fruit boxes, from the markets to the senders. In this matter the rules on the various railways are exceedingly uneven, and several hampering restrictions exist. Thus, on the Bombay, Baroda and Central India Railway, empty fruit packages, if carried at quarter parcel rates, must be returned to the station of arrival within seven days; otherwise full rates are charged. In other cases the time limit is ten days, while on the North-Western Railway and on the Oudh-Rohilkhand Railway fruit boxes are returned free, on certain sections of the line. A great deal could be done to help the trade if the railways could arrange for the free return of fruit packages of standard size, and also agree to abolish all hampering restrictions as to minimum rates and dates of return. This would be a material inducement to dealers to adopt better methods of packing and also to use the unit gift packages like those referred to above (pp. 256 and 257).

The question of the numerous thefts in transit, on the railways, remains to be mentioned. These cases are exceedingly numerous and they amount to nothing short of a scandal. At the present time, each package has to be securely fastened and sealed, somewhat after the manner adopted in sending insured articles by post. It is obvious that this involves a vast waste of labour and also increases the cost of fruit to the consumer. Fruit packages sent long distances must be ventilated, and to secure such parcels from theft is a difficult matter. The adoption of adequate remedies against theft, capable of being carried out in practice, is obviously a matter that can only be dealt with by those conversant with the details of Railway management.

V.—Conclusions.

It now remains to sum up the various subjects dealt with in this paper.

1. Experience at Pusa and Quetta has shown that the present methods of growing and transporting fruits, in India, are exceedingly primitive, and that far better results in both these directions are easily possible.

2. In the plains, delicate fruit like peaches can be transported without damage, when practically ripe, by means of bamboo baskets containing small cells for each peach.

3. Non-returnable packages, made of wood and chip imported from Glasgow, have been put on the market, at Quetta, at prices within the means of Indian fruit dealers. By means of these packages delicate fruit like peaches, grapes, and tomatoes can be sent to Calcutta, a distance of 1,750 miles, without loss or damage.

4. At present the ideal system of sending fruit on a large scale, to distant markets, is to adopt a suitable unit gift package, such as a punnet, and to pack these in non-returnable crates. These units should be sold as such, direct to the customer.

5. All delicate fruit should be wrapped in paper. The most suitable packing material so far found is *san* fibre, obtained in pressed bales from Oudh.

6. For short distances especially on the North-Western Railway where empties are returned free, there is an opening for returnable fruit packages such as those described in this paper.

7. In marketing fruit, it would be an advantage if an arrangement could be made to obtain, daily, the retail prices charged in the Bombay and other large markets. Efficient fruit auctions, at the larger centres, would be an advantage to the grower.

8. At present, in India, the provision of refrigerator cars for fruit on the railways, and cold storage facilities at the markets, is not likely to pay.

9. The rules for the transport of fruit and empty packages on the Indian railways are not uniform. Arrangements should be made to grant two concessions to the users of fruit packages of standard size; in the first place the consignments should be charged for on the collective weight and not on the weight of each separate package; in the second place returned empties should be carried free.

10. Thefts in transit should be reduced to a minimum.

THE ORGANIZATION OF SEED FARMS IN THE CENTRAL PROVINCES.

BY

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THE Central Provinces Agricultural Department has for several years paid particular attention to improving the types of seed in common use among the cultivators of these Provinces. This, in fact, may be considered almost the chief business in hand at present.

The general adoption of better methods of cultivation, important as it is, is an objective which will only be attained after years of patient efforts. To popularize improved implements and labour-saving machinery will also be a matter of time, owing to the absence of capital and initiative among the agricultural classes themselves. On the other hand, the staple seed supply of the Province affords scope for an immediate improvement, simple to demonstrate and easy to perceive, the practical adoption of which presents no serious difficulty to the average farmer. The present supply is of inferior quality and contains an admixture of more than one variety. The product is poor, variable, and of no recognized commercial status. The testing and introduction of improved varieties, and the inculcation of the doctrine that the crops raised from pure seed are the more profitable to grow, constitute therefore at the present time one of the most important aspects of the local Department's work. This article proposes briefly to describe the various types of seed farms at present in existence in the Central Provinces, showing how each type has developed and what progress it has so far made.

2. In the first place the isolation of pure high class varieties—a matter of primary importance considering the inferior mixtures now being grown—is undertaken on the Government farms. This branch of work presents comparatively little difficulty to the trained investigator, though several years of laborious selection, testing, and propagation are generally necessary before sufficient seed of the improved variety is available for trial by the public at large.

The next step is to advertise the seed by means of demonstration plots, exhibitions, and agricultural meetings. It is then handed over to selected members of the District Agricultural Associations, and under the supervision of the Department is tried on a field scale under varying local conditions. The outturn is compared with that of the common local variety, and, when results are favourable, a local demand for pure seed soon springs up.

This is seed farm organization in its simplest form, *i.e.*, a central area directly controlled by Government, feeding small private plots owned by well disposed farmers in the neighbourhood. The co-operation of the farmers is necessary because the Government Agricultural Stations are far too limited in area to be able to meet a growing demand for the new variety of seed. In every district of the Central Provinces an Agricultural Association of the leading land owners has been formed, and in the absence of a better organization these are, as above stated, utilised as the agency for the dissemination of the pure seed from the Government farms. The seed is sold exclusively to members of the Associations, each of whom agrees to grow it on a properly managed seed farm.

3. As exemplifying this form of organization it may be stated that this year 42 seed farms for selected kinds of wheat were under the supervision of the Department in the Northern wheat tract. These seed farms are arranged in groups within easy distance of a good grain market so that the surplus produce, as soon as the demand for seed in the neighbourhood has been satisfied, may realise a full price, and thus further emphasize the

advantage of growing pure varieties. Definite rules of management are prescribed. The growth of two varieties is prohibited; and the necessity for a separate threshing floor for the new crop, separate storage of the produce, and regular inspection by the itinerant Agricultural assistant in charge of the circle, is emphasized. The area to be sown in the case of wheat must not be less than 25 acres in the first instance. Otherwise it is found by experience that the grower will not make a separate threshing floor. Reports on these seed farms are submitted at each meeting of the Agricultural Association.

4. The organization through District Agricultural Associations is defective, in so far as it is difficult to get the essential rules properly carried out, in the branch seed farms, by large land owners (of which the District Agricultural Association is primarily composed) actuated more by a desire to please than by any real idea of practical business. But after two or three years it is generally found that a more highly articulated system comes almost spontaneously into existence, as the cultivators begin to realise the benefits of combination. Diversity of agricultural interests even within a single district develops smaller units of control. Thus a Sub-Association was started three years ago near Seoni-Malwa in the Hoshangabad district in a small tract suited to a certain variety of *maghai* til. The new variety was not known on the local markets and when sold in small quantities realised no better prices than the local til. But by marketing the total surplus produce on a single day an extra Rs. 3 profit per acre sown was obtained, and that without necessitating the slightest change in the current method of cultivation. In the third year (1912) over two thousand acres were sown and the market is now well established. Now even the Sub-Association is being split up. The new til deteriorates rapidly by cross-fertilization with the indigenous variety, and realising this, the cultivators of small groups of 15 to 20 villages each, are arranging to exclude the local til altogether, and have engaged the services of a trained farm hand whose duty it will be to see that the quality of the seed sown

is up to the mark. Each group has a central seed farm or seed farms supplied with fresh selected seed from time to time from the Government Farm. The above is an excellent example of how the loose organization of seed farms under the District Agricultural Associations splits up naturally into smaller areas of control shaped by community of interest.

5. In Berar a somewhat parallel but even more articulated development in the control of seed farms has occurred. After much experiment on the Akola Farm, a variety of cotton known as 'Rosea' had been found to give the best profits, per acre, to the local cultivator. It is short stapled but hardy and prolific, and has a high ginning percentage. The demand for seed is very great, 'Rosea' seed often fetching more than twice the price of the ordinary local variety. Last year 90 privately owned cotton seed farms, of the nature of the wheat seed farms described above, were growing 'Rosea' cotton. But for the whole of Berar 500 such seed farms would scarcely suffice; and the question of a local organization to control the ever-widening circle of seed farms arose in a very prominent manner. Here, too, as in the Hoshangabad district, Co-operative Credit is in its infancy and could give no help. Direct supervision by the Agricultural Department was also manifestly unsuitable, and the District Agricultural Associations were clearly incompetent to grapple with the situation. After much consideration it was decided to organize by official agency local areas of control smaller and more definite in shape, but following the line of development indicated by the groups of the Seoni-Malwa Sub-Association. As an experimental measure three so-called Agricultural Unions have accordingly been started. Each Union controls some 500 acres, growing improved cotton, in a small circle of adjoining villages. Each employs a Kamdar trained, in cotton cultivation and selection, by the Agricultural Department, and paid by the levy from the cultivators of $1\frac{1}{2}$ to 2 annas per acre sown. Each Union will eventually, it is hoped, have a small, power ginning plant of its own. In this way a very large area should be sown with

pure seed in the course of the next few years. Other improved strains, obtained from the Government Farm as occasion arises, will also be disseminated through the agency of these Unions.

6. But even the Berar system is admittedly incomplete, and will not be expected to reach its fullest development until, as in the Jubbalpur district, these Agricultural Unions controlling the seed farms are brought into close connection with a number of Co-operative Credit Societies. This consummation has been achieved in the Sehora Tahsil of the Jubbalpur district for the simple reason that nearly two-thirds of the villages of that Tahsil have now each its own Co-operative Society. Certain enlightened members of the Jubbalpur Agricultural Association have, for the last five years, been trying new varieties of wheat, gram, etc., with a view to improving the present poor quality of the crops. The variety known as Sukerhai Pissi was found to yield far better than the local wheats and to realise a higher price if marketed in bulk. Two other varieties known as *Bansi* and *Hansi* were also found to suit certain classes of soil and position. A new variety of gram and several new rices were proved to be profitable. Four large wheat seed farms of the usual type were started, but although they comprised an area of over 300 acres the demand for seed in the first year far exceeded the supply: and it was evident that if the demand was to be met, a number of seed farms would be needed which it would be impossible for the Department to supervise. After much discussion and many initial mistakes the following system has been finally evolved:—

Agricultural Unions, composed of Co-operative Societies, and not of individual members, have been formed. Each Co-operative Society appoints one of its members to act as Kamdar or Manager; and he is responsible that the individual members carry out the rules intended to ensure that the new varieties are kept pure. Once or twice a year the Union Committee meets in the central village. It is composed of the Kamdars of the various Societies which are incorporated in the Union. The President is a leading Malguzar who has a large seed farm on

which fresh seed from the Government Farm is grown each year. The President, besides being a member of the District Agricultural Association, is also a Director of the Co-operative Central Bank at Sehora. At these meetings each Kamdar reports what his Society requires for the following season and how much surplus stock is available for sale. In order to purchase the seed they require, individual members borrow money on the usual terms, from the Central Bank. The Kamdar receives a small annual remuneration from the other members of the Society in return for the services he renders.

Incorporated with the Agricultural Unions is a Central Seed Store, situated in the buildings of the Crosthwaite Central Bank, Sehora. This seed store registers orders for seed, and arranges the supply from the incorporated seed farms. It also arranges for the disposal of surplus produce in bulk, so that the highest possible price is realised and full value for the improvement in quality obtained. The seed is graded by a specially trained man, and no seed not up to standard is thus sold for seed from the seed farms. The managers of the store will eventually be responsible for the supervision of the Kamdars of each Agricultural Union, but at present this duty is being performed by an Agricultural Assistant until the Seed Store is in a position to obtain a better trained staff.

7. Three such Agricultural Unions have, at present, been organized :

The *Bargwan Union* consists of 9 Co-operative Societies in the villages immediately surrounding Bargwan, the farthest not more than 5 miles away. The President is Rai Sahib Gurudin Misra, Director of the Central Bank, who resides at Bargwan and has a large seed farm of 400 acres. Many cultivators already grow improved varieties in these villages and this year the following quantities of pure seed have been ordered by this Union alone :—

Sukerhai Pissi	...	...	... 41,880	lbs.
Bansi wheat...	...	...	... 15,200	„
Malida gram	...	...	... 7,000	„

The area under pure varieties controlled by the Union this season will be approximately 1,600 acres.

Two other Unions are in process of formation, controlling an area of about one thousand acres.

8. The Jubbalpur organization is, as will readily be seen, by far the most advanced, and remains for these Provinces the standard to which it is hoped gradually to raise the supervisory system of the other districts. But no mere imitation will give the best results, and every opportunity is being allowed to the Association of Hoshangabad and to the Unions of Berar to develop along the natural lines most likely to suit them. The one accepted principle, however, is this, that, wherever Co-operative Societies exist, the Agricultural organization must be worked through them, to the mutual advantage both of the Societies and of the system of control, whatever it may be, under which the seed farms may be placed.

It is hoped within a few years that Co-operative Credit Societies will be organized in all the districts where Agricultural development shows the greatest promise. The linking of these Societies into small self-supporting and self-regulating Unions, themselves co-operative in form and practice, will then constitute the agency through which in common with other agricultural improvements we shall be able to foster the dissemination of the higher types of pure seed.

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THE CULTIVATION AND TRANSPORT OF TOMATOES IN INDIA.

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I.—Introduction.

In connection with the work relating to the development of the fruit industry of Baluchistan the question of the profitable production of vegetables for the Indian market was considered. Some of the English vegetables grow to perfection at Quetta and are ready for the market in July, August and September. Such produce is almost entirely absent from the markets of the Indo-Gangetic plain at this period, so that Quetta grown vegetables would be likely to sell at remunerative prices in the plains of India if suitable methods of transport could be devised. Accordingly, a beginning was made in this work in 1911 when a few experimental consignments of tomatoes were sent to Calcutta, a distance of 1,750 miles. These preliminary trials showed that the quality of the produce was all that could be desired and that a good market for out of season vegetables existed in Calcutta. In the following year, 1912, it was decided to extend the experiment and to try an improved system of packing. At the same time, the methods of cultivation of this crop, both in the plains and in Baluchistan, were studied. The fact that the tomato

grows very easily, and produces fruit without trouble, probably accounts for the want of care devoted to this plant. Only in one case, namely, in the garden of Colonel Duke, I.M.S., Residency Surgeon and Chief Administrative Medical Officer in Baluchistan, were properly cultivated tomatoes observed. Here the plants were trained on wires, two stems to each plant, and all the side suckers were pinched off. The result was large crops of well-grown, evenly ripened fruit which could be picked without damaging the plants. It was decided to adopt this system on a large scale, combined with furrow irrigation; and, accordingly, experiments were made at Pusa, in Bihar, in the *rabi* season of 1911-12 and again at Quetta in 1912. In both cases the results were successful. A portion of the Quetta crop was sent to Calcutta where it was sold at good prices, the remainder being disposed of locally, to Army contractors, at the rate of three rupees a maund. The area under experiment at Quetta was four-tenths of an acre, for which a sum of Rs. 842 was obtained, although at least half of the crop was destroyed by abnormally early frosts in August and September, and could not be sold. About 10 tons of saleable fruit was, however, collected from this area, the yield being at the rate of 25 tons to the acre. Similar crops were obtained at Pusa in 1911-12 and again in 1912-13. These experiments have been so striking that it has been decided to publish the results, in the hope that more attention will be paid in the future, in India, to scientific methods of production in vegetable growing.

II.—The Cultivation of Tomatoes.

Seedlings.—Insufficient attention is paid, in India, to the raising of the tomato seedlings and young plants. The best results are obtained when the seedlings are transplanted in the nursery, once, and this should be done when the first pair of rough leaves are fairly well developed. They should be set out in a well prepared nursery, about three inches apart each way, and should be planted deeply—the stem up to the seed leaves being completely buried. Care must, of course, be taken to accomplish this

transplanting without serious damage to the roots. The seedlings should first be well watered about two hours beforehand and then taken up by means of a small trowel with as much moist earth adhering to the roots as possible.

After transplanting, the nursery should be well watered, and the surface, when dry enough after each watering, should be broken up and kept in a fine condition. This cultivation, which is usually neglected in India, is most important, as also the proper spacing of the seedlings. In this way vigorous, stocky plants are produced and there is no check in growth, an important point in the case of the tomato. The young plants must be well watered, but not overwatered, and when the stems are as thick as the little finger and the plants are five to six inches high, they are ready for the final planting out. The Indian gardeners, if left to themselves, are not likely to succeed in this portion of the work of tomato growing; through overwatering and want of cultivation they raise weedy, drawn, weak plants with hardly any roots, which die off wholesale after the final planting out.

Irrigation.—The irrigation of the tomato crop is an important matter in India, not only in the arid climate of Baluchistan but also in the plains. In the application of irrigation water to tomatoes two conditions must be fulfilled. The plants must get sufficient water, both for vegetative growth and also to swell the fruit, and it must be remembered that the tomato does not like dry soil. At the same time the tilth must on no account be destroyed, otherwise the plants will not thrive and will not yield the maximum crop. Surface flooding, the usual method of irrigation at Quetta, is therefore out of the question, as by this means the tilth is destroyed and, in addition, an enormous amount of water is lost by evaporation, particularly during the period of the dry westerly winds. The easiest method of applying water without destroying the tilth is by means of furrow irrigation. This system has the additional advantage of saving a large amount of water.

The method of irrigation by means of furrows is particularly applicable to fine alluvial soils, in which the lateral percolation

PLATE XXX.

FURROW IRRIGATION.

from a trench filled with water is considerable. This system of irrigation presents no difficulties. After the final preparation of the land, furrows, about 18 inches wide at the top and from 4 to 5 inches deep, are laid off at the proper distance. The floor of the trench should be about 15 inches wide, and the sides should slope so as to prevent the furrows filling with earth from the edges. The land should be laid out so that there is a furrow between alternate rows of tomatoes.—Plate XXX shows the arrangement in the case of tobacco. The rows of tomatoes should be at least three feet apart, and the plants should be spaced from two to three feet in the row. In laying out the land, it is an advantage to mark the position of the ends of the rows of tomatoes first of all, by means of pegs, and then to make the furrows. After the land between the trenches is levelled, the lines of tomatoes can be laid off and the positions of the plants indicated by short pieces of twig or straw.

Water is given by filling the furrows, whenever this is necessary. It should be remembered that while the tomato does not thrive in dry soil nevertheless overwatering during the ripening stage leads to much splitting of the fruit. No rule can be given as to the amount of water required to suit all circumstances. In this matter the successful grower soon learns to read his practice in the plant itself.

Planting out.—Two or three days before the final transplanting, the furrows are filled two or three times from a distributing channel which runs at right angles to the trenches. The water percolates laterally, and soon the soil is well moistened between the furrows. As soon as the earth is dry enough for the purpose, the tomato plants are set out in the soil which has been moistened by the lateral seepage from the trenches. The plants should be deeply planted, right up to the leaves, and the soil should be properly consolidated round the roots. About half the leaf surface of the older leaves should be pinched off, and the young plants covered by means of leafy twigs during the day for the first two days. In this

way the losses on transplanting are exceedingly small, a good even stand of plants is obtained, and there is very little check in growth.

Cultivation.—After the plants are established the cultivation of the surface is an important matter in this crop. The aim should be to maintain a dry surface mulch on the beds and around the plants, and to keep down all weeds. The labour involved in this is much reduced by the use of the Planet Jr. double wheel hand hoe, which can also be used to break up the crust which forms on the floor of the furrows as these dry. In an arid climate, like that of Baluchistan, the loss of water by evaporation from the furrows is very great and, unless the crust is broken up, cracking takes place and the moistened soil sets into a hard intractable cake. In addition to this surface cultivation, the earth of the beds between the young plants should be deeply cultivated after planting out, at least once, with

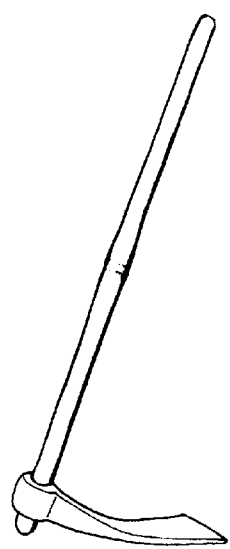


FIG. 1.—A PICKAXE (*kodár*) USED FOR DEEP CULTIVATION IN THE PLAINS OF INDIA.

the *kodár*, a kind of pickaxe shown in Fig. 1. This aerates the subsoil after the trampling of the workmen, and leaves it in the proper condition for rapid root development.

Pruning and training.—The method of pruning adopted, and also the system of training, are matters of great importance in the cultivation of the tomato. Both these subjects receive little or no attention in India.

If left to itself, the tomato produces a large straggling growth, which sprawls over the ground, rendering the collection of the fruit a matter of great difficulty. Under these circumstances, most of the tomatoes lie on the damp earth, and the amount of decay is considerable. The fruit produced is small in amount and often deficient in flavour. The absence of sufficient sunlight also prevents the proper development of colour. These results follow from the unchecked vegetative growth of the plant. Instead of the energies of the tomato being used for fruit production only, a large number of unnecessary branches are developed, which interfere with the well-being of the crop. Some system of pruning is, therefore, essential. The method adopted at Quetta and Pusa is to restrict the vegetative growth to two branches only and to pinch off all other growth. As is well known, the main stem of the tomato plant, when a few inches in length, ends in a bunch of flowers. On either side of this a lateral branch is formed. These laterals themselves will give off other branches and further branching will take place on the lower portions of the single main stem if the plant is left alone. The object of pruning in this crop is to remove all side branches, which form on the two laterals and on the single main stem, as soon as possible. This is done by pinching off these shoots as they appear. The whole growth is, therefore, deflected into the two main arms, which rapidly grow in length and give rise to successive clusters of flowers.

In addition to pruning, some method of training is necessary for the tomato. The stem is too weak to stand erect and at the same time bear a heavy crop of fruit. The absence of bamboos at Quetta and the scarcity of wood, account for the fact that the local gardeners make no serious effort to train the tomato. In India, more is done in this respect, and tomatoes are often seen

either supported by vertical or inclined bamboo frame work. A more effective arrangement is to train the plants on wires, supported either by short poles or by the ordinary iron standards used in wire fencing. The wire and iron standards can be used over and over again, while, in a dry climate like Quetta, short willow poles will last several years if properly stored. The posts for supporting the wires should be from four to four and a half feet high when placed in position, and either three or four wires should be used. The lowest wire should be about nine inches above the ground, and the highest should run level with the tops of the poles. Between these, the other wires should be arranged, at regular distances. The plants can be tied to the wires by means of banana fibre or strips of mulberry bark. Trained in this way the tomato forms almost solid walls of green foliage loaded with fruit, after the manner shown in Plate XXXI. There is plenty of room for development, the fruit receives the necessary sunlight, and even ripening takes place. Picking is greatly facilitated, and no damage is done to the plants in the process. Moreover cultivation can go on uniformly till the whole crop has been gathered.

III.—The Packing and Transport of Tomatoes.

The results obtained at Quetta in 1912 proved that tomatoes could be sent to Calcutta, without loss or damage in transit. The distance is approximately 1,750 miles, and the journey takes about four days. The consignments had to withstand not only the dry heat of the desert as far as Delhi, but also the high temperature and high humidity of the monsoon period on the journey through the Gangetic plain.

These results were not achieved without some attention to detail. In bringing this portion of the work to a successful issue it was found that the most important matters were the following:—

1. *Picking.*—The tomatoes must be picked at the proper stage neither too green nor too ripe. If too ripe and soft when packed the fruit does not last long enough in good condition after arrival, for sale purposes. If picked too green, the full

PLATE XXXI.

TOMATOES ON WIRES.

TWO-BRANCH SYSTEM.

flavour does not develop. Good results were obtained when the tomatoes were gathered when they were beginning to turn red all over and before all the green colour had disappeared. They are best picked by twisting off the fruit from the stalks, and they should be packed without the stalk, as this often projects beyond the base of the fruit and causes damage to other tomatoes.

2. *Wrapping.*—The fruits should be separately wrapped in thin paper, and only perfect specimens should be selected. There is obviously nothing to be gained in the attempt to send second class produce by passenger train to a distant market, like Calcutta, accustomed to handle the best supplies obtainable. Picking should be done early in the morning, when the fruit is cold, and the packing should be done in the shade. By wrapping tomatoes in paper when cold a great transport advantage is obtained. The ripening processes are delayed, and cold wrapped fruit heats up very slowly on the journey. In this respect Baluchistan has an enormous natural advantage over its competitors in the fruit trade. With a little care quite cold fruit can be packed at Quetta and all the advantages of pre-cooling before transport can be obtained without any trouble or expense. This enables fruit to be picked in a much riper condition than would otherwise be possible, thus ensuring the maximum flavour on arrival consistent with safe transport.

3. *Packing.*—The package used for tomatoes is a matter of considerable importance if the journey is a long one. This point has been dealt with elsewhere (p. 256), in connection with the problem of fruit transport in general, and it is unnecessary to do more than refer to it here. They are packed in punnets (Fig. 4, p. 256). Two methods are possible; medium sized fruit after wrapping can be packed edgewise. Large fruits are best packed flat, four in a punnet. In both cases the floor and sides are lined with *san* fibre and the fruit must be tight in each punnet. This is best accomplished by filling up the small spaces by means of the fruit of the smaller varieties such as cherry and pear tomatoes. Care must be taken that the tomatoes do not project beyond the edges of the punnets, otherwise they will be crushed by the floor above. To

fill the punnets completely, a little *sann* can be placed above the tomatoes in each.

These crates can of course be used for other produce besides tomatoes—such as grapes, peaches and plums. In 1912, a number of these packages, containing a variety of fruits and vegetables, were sent to Simla and Calcutta during August and September. It is hoped that by this means the Quetta fruit dealers will supply customers in the plains with mixed consignments of the produce of the valley. The separate punnets enable a variety of fruits to be sent in one package.

4. *Marketing.*—The method of offering fruit for sale is an important matter, and one in which the Indian fruit dealers have much to learn. There should be no sorting or handling of the produce after the market is reached. The ideal method is to offer each unit of fruit for sale in a suitable gift package of such a character as to encourage the purchaser. These units should be packed in outer crates, in the manner already described. For tomatoes, the two pound chip punnet measuring $7\frac{1}{2} \times 7\frac{1}{2} \times 3$ inches is a suitable gift package for every seer of fruit. Put up in this way retail marketing is a simple matter; the units are ready for immediate sale, and there is little trouble to the seller. A large consignment of Quetta tomatoes, packed on these lines, was sold in the shop attached to the Great Eastern Hotel, Calcutta, in 1912,—each unit of one seer fetching twelve annas. The cost of packing and railway freight was about four annas a seer.

There is no doubt that, if proper attention is paid to the cultivation of the tomato at Quetta and to the proper packing of the produce, a large market can be found in India. It has been shown that there is no difficulty in sending the produce as far as Calcutta. In addition to this large market, there are many intermediate towns which could absorb a portion of the crop. Further, the demands of the various hill stations and military cantonments within reach could also be met. The crop is ripe during August and September, when the only vegetables available in India are various insipid gourds. Tomatoes offered for sale at this time would find a ready market.

THE CULTIVATION OF RUBBER BY MEANS OF PLOUGHS.

BY

C. S. THANE,

Manager, Rangoon Para Rubber Estates, Tavoy.

On several Estates in the mid East ploughs and harrows are now being used as a means of cultivating rubber.

The chief objects of this ploughing may be said to be :—

(*a*) To destroy grass and bury herbage and refuse.
(*b*) To pulverise the soil.
(*c*) To promote fertility.
(*d*) To increase the water holding capacity of the soil.
(*e*) To establish a mulch.
(*f*) To reduce expense.

By using such ploughs as will accomplish the results desired in items (*a*) and (*b*), the other results are bound to follow. Should the area to be ploughed be heavy in grass, refuse, or fallen leaves, the land should be ploughed deeper than if it is clean : as refuse, leaves, etc., decay more rapidly when ploughed under deeply than if they are turned under with a shallow furrow, because the surface soil is drier.

Nevertheless the depth to plough should chiefly be governed by the nature of the soil and the root system of the trees. Generally speaking, the heavy soils require deeper ploughing than light soils as they need the effect of the loosening, draining and aërating more than light sandy soils, but owing to the root system of rubber each planter can best judge for himself. Three or four inches should be the minimum depth of ploughing.

To destroy weeds and keep the weeding in hand in Burma, fortnightly rounds may suffice until January, after which very

few weeds grow, and then monthly rounds during the dry season; but here again the soil must be taken into consideration, as it is essential to keep a soft mulch of earth on the surface to a depth of 3 or 4 inches.

For pulverising the soil and burying grass, leaves, etc., a disc or rolling furrow plough is generally the best, as it buries and crumbles the soil in one operation. Disc ploughs or harrows are probably the most useful of the many kinds of ploughs in use, being especially good for working heavy soils; they, however, have one or two disadvantages, they are apt to leave the soil in rather high ridges, which evaporate much moisture; but this is easily overcome by dragging a small log behind. Also, unless adjusted properly, they leave a ridge of unstirred soil, to avoid this the discs should be set so that they will enter the soil at a wide angle. These disc harrows generally throw the soil from the centre outwards, so that it is necessary to overlap in order to keep the ground level, or else to plough at right angles to the previous time. For bullock draft 8 disc ploughs are the largest that can be used satisfactorily, and here at Twante, for each plough I have two pairs of bullocks, one day on and one off (water buffaloes should prove just as good draft as bullocks), but I think that by feeding them with a little chaff (paddy straw) and oil cake, it will be possible to use each pair daily; at present the only feed the cattle have is grass on our reserve area.

Costs.—The daily tasks are three ploughs to ten acres: one man at 8 as. a day works and drives a plough. The soil is ploughed to within two feet of the older rubber trees and about 1½′ of the young rubber. Between January and June the cost of cultivating ten acres should not exceed 6 annas per acre monthly, made up as follows:—

3 ploughmen @ 8 annas each a day, = Re. 1-8, two coolies @ 8 annas each a day, Re. 1 (for loosening the soil around the trees where the ploughs don't touch). Food for 12 bullocks @ 1 anna each, 12 annas. Oil for ploughs, 1 anna. Sundries, 5 annas. A total of Rs. 3-10 for 10 acres or 5·8 annas per acre.

From June to December, during the wet season, it may be better to work the fortnightly rounds with coolie labour and hoes than by ploughs. At present I have not sufficient data to go upon. If we take A II Division of this Estate of 390 acres, 4 ploughs doing 13 acres a day will cultivate this area once in a month and the following figures will show the total cost per acre per mensem :—

		Rs.
4 ploughmen @ Rs. 15 each p.m.	...	
3 coolies " 15 "	...	... 60
Feed for 16 bullocks @ 1 anna each per day for one month	...	... 45
Oil one month's supply for ploughs, say	...	... 30
Sundries, hide for tying yokes, new yokes, bolts, etc.	...	... 1
		... 14
		Rs. 150

that is, Rs. 150 for 390 acres or 6·2 annas per acre. For the six months of the dry season, December to May inclusive, it would cost Rs. 900. 4 disc ploughs cost Rs. 195 each, c.i.f. Estate, say Rs. 200 each, = Rs. 800. Taking the life of a plough at 1 year, or two dry seasons, depreciation would be 50 per cent. or Rs. 400—making a total of Rs. 1,300. For these four ploughs are needed 8 pairs of bullocks, say at Rs. 170 a pair, = Rs. 1,360. Take the working age of a bullock as low as 5 years and allow 20 per cent. depreciation, *i.e.*, Rs. 272—making a total of Rs. 1,572 for six months' working, or Rs. 262 per mensem, or annas $10\frac{3}{4}$* per acre per mensem. To do the same class of work with coolies using hoes or kodali forks it will cost at least Rs. 3 per acre per mensem, as it is a physical impossibility for less than six coolies to dig up an acre of land in a day, in fact Rs. 4 per acre would not be an exceptionally high cost.

A disc plough should also last longer than one year, if well looked after and oiled daily, as I have one which has been in constant use for eleven months, and it appears as if it would last another two years at least.

General.—Another advantage the ploughs have, is that they turn the soil, whereas hoes and forks do not do so to the

* The actual cost of cultivation—including depreciation as here estimated—has proved during the recent dry season to be As. 11½ per acre over an area of nearly 2,000 acres.

same extent, nor do they crumble the soil so well. Also coolies cultivating with hoes or forks require close and much more supervision than do ploughs, and there is much more likelihood of ground being scamped when done with hoes or forks. At present the only disadvantage disc ploughs may be said to have is that they damage the roots; so do hoes or forks but possibly in a lesser degree; but if a dry mulch of 3 or 4 inches is kept on the surface, the roots will naturally go deeper into the soil, which is kept moist owing to this blanket or mulch of dry soil, and little or no injury will be done. Ploughs naturally do best work on gently undulating or flat land, but steep slopes may be ploughed satisfactorily by ploughing across the slopes. Above ground, slight damage is sometimes done by the ends of the yoke striking the tree, but this can be avoided by cutting off the ends of the yokes as short as possible. Unfortunately, I have at present no figures to show to what extent cultivation increases growth and yields here in Burma, but we do know that, owing to this system of cultivation in Australia and America (dry farming as it is called) hundreds of thousands of acres of land have been made to yield crops of wheat, rye, sorghum, etc., that compare favourably with yields in the humid regions of both these continents. Speaking of yields the older trees on this Estate have been tapped daily since September, 1910, with the exception of a half day in the rains 1911 when 4" of rain fell, and the yields are now as good as ever they were. During 1912, records have been kept of the yields from 7½ acres containing trees aged from 5—9½ years and the yield was 407 lbs. dry rubber per acre; and this year's yields promise to exceed last. If the manuring of rubber estates eventually has to be done, good and frequent tillage or cultivation will largely reduce the manure bill and delay the day when fertilisers will be needed.

In conclusion, I am of the opinion that from June to September Estates in Burma should be weeded fortnightly, the weeds being just cut off on the surface. In October a deep forking; November a digging with hoes, and then, for the rest of the year disc ploughs.

TRANSPLANTATION OF RICE IN CHHATTISGARH.

BY

D. CLOUSTON, M.A., B.Sc.,

Deputy Director of Agriculture, Central Provinces.

THE cultivators of the Chhattisgarh Division in the Central Provinces have a bad reputation as tillers of the soil. There are several causes to account for this low standard of efficiency. The country was for centuries ringed in by wide stretches of hill and forest which formed a serious impediment to all communication with the outside world: and this condition of affairs continued till as late as 1889 when the first railway line was carried through the tract. There is a large population of *chamars* in the Division who are noted for their thriftlessness. The local breed of cattle is so small that the draught bullocks are not sufficiently strong to cultivate the soil properly. These cattle get very little stall-feeding and the grazing being extremely poor they satisfy their hunger by devouring the field crops: there is a universal custom by which all the cattle of the village graze together, over the fields and waste lands alike, from December till June and much difficulty is therefore experienced in saving the seedlings of the nursery beds for the rice area that is being transplanted each year.

The population suffers much from malaria during the rains and early cold weather: cultivators subject to chronic malaria become lethargic and their work suffers in consequence. The now extinct *lakabhata* system of land re-distribution has left each cultivator with a number of scattered plots of land in the

cultivated area of the village instead of a concentrated area. This further handicaps any attempt at the introduction of intensive methods of cultivation, which would be possible if each cultivator's area were consolidated.

A farming community working under such adverse conditions is naturally opposed to the introduction of any improvements which demand more energy, intelligence and skill. They are mentally and physically incapable of changing their methods all at once: they must needs be led by easy stages from that lower standard of farming with which they are content at present, to the higher standard which involves new ways of doing things and which therefore demands intelligent effort. But as the existing standard of intelligence is also low, one must in a case of this kind base all instructions on actual demonstrations conducted in the villages themselves. This has been done: the ryots in thousands of villages in Chhattisgarh have during the last six years been shown how to transplant their rice.

With the limited number of Agricultural Assistants at our disposal it would have been impossible to have done instructional work in several hundreds of villages each year, had not another device suggested itself, *viz.*, to employ as instructors a superior type of intelligent and literate ploughmen recruited in districts where agriculture is more advanced. These instructors are designated Kamdars. This scheme for the employment of Kamdars who should serve the purpose of instructors in new methods of farming has been tried in Chhattisgarh for the last five years and has proved to be a very sound and practical one. These men at first serve for a time on the Raipur Experimental Farm where they get into touch with our methods. This is necessary, as the work for which they are mostly required is the transplantation of rice and the cultivation of cane, and though they may have had experience in both, still they have much to learn. They have for instance to learn to transplant single seedlings instead of bunches since seedlings are transplanted in bunches wherever transplanting is practised in these Provinces.

The advantages to be gained by employing these skilled Kamdars for demonstration work are—(i) that being men of cultivating castes they are more in touch with the ryot, (ii) that they work with their own hands and are therefore more effective as instructors than our assistants who, being in most cases of a non-cultivating class, are physically less adapted to the practical side of this work, and (iii) that nearly all our Kamdars have been recruited from villages in the rice tract, and therefore stand the climate much better than do our trained assistants of the higher castes recruited from the towns.

By steady work on demonstration lines the Department has in six years got an area of 16,000 acres transplanted where this method of cultivating rice was formerly unknown. Crop experiments, carried out in the villages from 1909 to 1911 by our Agricultural Assistants in collaboration with the leading landholders concerned, showed the following average *increases per acre* in favour of transplantation :—

Year						lbs. of paddy.
1909	...	...	...	...	...	687
1910	...	...	...	...	...	556
1911	...	...	...	...	...	693

As the accuracy of these figures had been questioned by certain influential malguzars who were opposed to transplantation, arrangements were made by the Deputy Commissioners in the current year to conduct these experiments.

The outturn, as recorded by the Assistant and Extra Assistant Commissioners who were entrusted with this work, shows that in the eleven villages in which the experiments were carried out transplantation accounted for an average increase of 1,052 lbs. of paddy per acre, while in 5 villages where a comparison was made between the very best transplanted and the very best broadcasted plot, the transplanted plots gave an average increase of 2,204 lbs. of paddy per acre.

We may take it that the yield of irrigated paddy can be increased by transplantation to the extent of one-third, and that the average increase for a period of several years would be some

way between 500 and 1,000 lbs. per acre. If we take even the lower figure, which in terms of money is at present prices worth about Rs. 13, it follows that the Department has in this division been the means of increasing farming profits of rice cultivators by approximately Rs. $13 \times 16{,}000 = 208{,}000$ in one season. It has at the same time reduced the seed rate for the transplanted area from about 80 to 25 lbs. per acre; so that by transplanting 16,000 acres 880,000 lbs. of paddy have been saved.

NOTES.

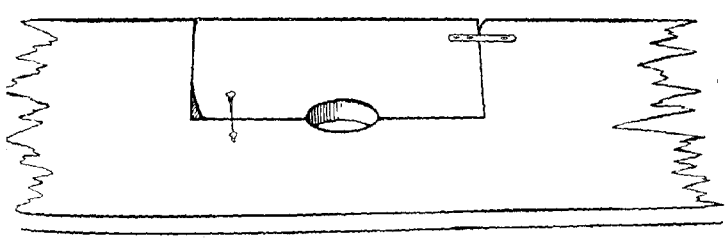
RESTRICTIONS ON THE IMPORTATION OF NURSERY STOCK INTO THE UNITED STATES.—In accordance with the Plant Quarantine Act of August 20th, 1912, the Secretary for Agriculture of the United States of America has issued regulations, which have the effect that, after July 1st of this year, Indian nursery stock will be admitted into the United States only for experimental purposes and in limited quantities. For such importations a special permit will be required.

The term "nursery stock" includes all woody plants and parts of plants, as well as seeds—except field, vegetable and flower seeds.

The text of the Act and of the Regulations has been published in the Supplement to the *Gazette of India* of April 5th, 1913.

* * *

A PLANT-HOLDER.—The sketch below shows a plant-holder recently made at the Agriculture College, Coimbatore, in reply



"PLANT-HOLDER."

to an order received from the Manager of an Estate under the Court of Wards. The contrivance is intended to hold the

young plant or tree securely and vertically while it is being planted. The construction is simple:—A plain board about six feet long, nine inches wide, and one and a half inches thick is taken. In the centre is bored a hole one inch in diameter, and, including half the hole, a rectangular piece is cut out as shown in the sketch. This piece moves on a pivot, and can be swung out to receive the tree, which is then held firmly in the hole. The piece is fastened in by a piece of string passing round two pegs. For smaller trees or when trees are delicate, a piece of cloth may be wrapped round the stem until the desired diameter is reached.—(R. CECIL WOOD).

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* *

PESHAWAR AGRICULTURAL SHOW.—The Annual Show of the North-West Frontier Province Agricultural Department was held on the Peshawar Agricultural Station on April 15th and 16th, and was attended on each day by over 3,000 agriculturists, some of whom came from over the border.

Competitions and demonstrations provided an extensive programme, including ploughing with both English and country ploughs, digging, and the use of the Planet Junior Horse Hoe—besides sports and livestock classes.

Competition in the events was keen, and the quality of the work performed was excellent. The ploughing was especially good, the furrows of 200 yards length being in some cases worthy of competitors in good English matches. The Pathan digs in English fashion with a good opening and a full-sized spade, and seventy-five men competed in this match. The work of the men who reached the final, was remarkably good and the prize-winners were chosen with difficulty.

In the year 1905 the Planet Junior Hand Hoes were practically unknown in England, and gardeners at home would have been much surprised to see how rapidly and deftly the thirty-three frontiermen adjusted their hoes, and sped up and down the long nursery lines, in weeding, cultivating, earthing up, etc.

Entries in the poultry classes were rather poor, but good fowls were shown and the success of this part of the show is assured for the future.

The Rajah Plough, the Meston Plough, the new American Lever Harrow, the Punjab Chain Harrow, the American Ring Press Roller and several other minor implements were at work, and were watched by critical groups of zamindars during the show, and the farm buildings were examined and discussed freely. Agricultural produce, cases of insects, etc., were shown in the farm museum.

The samples of English wheat and barley of which crops were in ear on the farm were especially admired, and some beautiful samples of cotton from the Imperial Cotton Specialist and from the Economic Botanist, Punjab, attracted much attention.

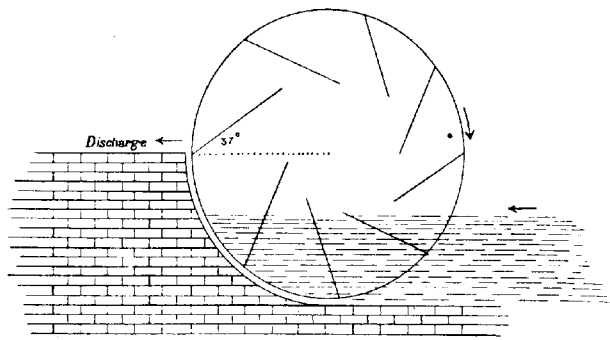
The sports competitors were all too numerous for the events of one short afternoon, and the games were hurried. Only three men succeeded in poising the weight (Mugdar) above their heads. But this is not surprising—the writer of this note could just raise the log off the ground.

The Hon'ble the Chief Commissioner had intimated that he would visit the show, but he was absent settling a threatened tribal disturbance on the border. Colonel C. B. Rawlinson, C.I.E., Revenue Commissioner, Mr. Mackenna, I.C.S., Agricultural Adviser to the Government of India, Mr. Barton, I.C.S., Judicial Commissioner, Mr. Bolton, I.C.S., Deputy Commissioner, and several Civil and Military officers visited the show. A short but violent duststorm arose just when the show was over, and prevented Mrs. Rawlinson from distributing the prizes. On the evening of the 15th, full 300 agriculturists were entertained to dinner and "tamasha" and visitors from a distance were entertained during their two days' stay at the farm.—(W. Robertson Brown.)

* * *

An Egyptian Water-lift.—A very useful water-lift for low-lift canal irrigation has recently been received from Egypt. It consists of two circular pieces of iron on an axis about 15 inches

apart. These two wheels are connected together by a number of vanes set on at an angle of about 37° to the radius—as in the drawing.



The whole thing revolves in a close fitting masonry basin. It is geared to run at a slow speed and the one I have is worked by one bullock. The wheel discharges the water at the height of its own axis as in the drawing.

This is by far the best machine that I have tried for low-lift irrigation.—(A. E. PARR.)

* * *

PLANTATION CROPS.—Owing to recent 'booms' in the rubber, tea, coffee and coconut industries and the stir created by the negotiations of the Levers with the Liberian Government for control of a large area for the growing of coconut and other tropical products, it is being increasingly realised that there is an almost virgin field open to the intelligent application of capital to tropical agriculture.

The facts appear to be that, in order to enable plants to take full advantage of the favourable conditions of temperature and powerful sunlight prevailing in the tropics, a proportionately great extension of the plant, in air and soil, is necessary—with the result that economy in tropical agriculture lies in the growth mainly of 'plantation' crops such as sugarcane, banana and other fruits, tea, coffee, rubber, etc., the cultivation of which

requires an amount of capital and security proportional to the initial expenditure on deep cultivation and the length of time for which the plantation occupies the ground before coming to profit.

But capital and security are comparatively recent bed-fellows among the inhabitants of warm climates, while the discomforts of life in the tropics for natives of cooler climates, have hindered the intelligent employment of capital by them in the moister regions where the best results are obtainable. Hence the field is still open.

Meanwhile Agricultural Colleges in India are turning out a large number of highly educated young men for whom there is no visible means of subsistence outside Government service. In the growth of ordinary crops, they cannot compete with the ryat—who is fully alive to the advantages of any improvement introduced in the cultivation of such crops, and so realises the full value of his labour on his own land, and will not work elsewhere for any wage that pays the employer who can only grow the same crops in the same way.

It is therefore only by the judicious use of capital and special knowledge that the educated Indian can hope to make farming pay. Does not the cultivation of plantation crops offer exactly the opening that he requires?

The graduate of an Indian Agricultural College, with a *good* technical education, should be able, with a comparatively small stock of capital, to compete with the European planter—who has all the disadvantages of an alien, and who will not live in a tropical climate except in return for a relatively high rate of interest on the capital invested in his education and on his plantation.

At any rate the present profits are undoubted, and the outlook appears to shew an ample field for both.

From this point of view the systematic investigation of the potentialities of such capitalist's crops, and instruction in the technicalities of their cultivation and disposal, might well form one of the main lines of work in Agricultural Colleges.

One of the more obvious subjects for such investigation is the wild date palm which flourishes wherever rice is grown, and which seems capable of development as a sugar producer on a much larger and more important scale.*

But there must be many other such woody plants of known importance, besides those already commonly grown in plantations, the economics of the systematic cultivation of which would repay local scientific investigation.

* * *

Coconut Cultivation has been the subject of several recent abstracts in the Bulletin of Agricultural Intelligence and of Plant Diseases issued by the International Institute of Agriculture, Rome (notably in the issues for September, 1912, and January, 1913) which condense into a very small space an enormous amount of detailed information on costs, methods of cultivation and manuring, and utilisation.

Estimates of the capital cost, per acre, of plantations, vary from between £12 and £16 for a plantation of 2,500 acres, to £32 for clearing and planting one of 500 acres.

The cost of production of copra in Ceylon appears to be under £7-10 per ton and the price about £22, leaving—on an estimated production of about 15 cwts. per acre—a profit of £10 per acre, for rent and interest on capital, when in full bearing.

* * *

Sugar from Nipa Fruticans.—In a recent Memoir Mr. H. E. Annett says of the Nipa palm:—"This plant grows in low-lying lands by the sea in the Sunderbans, Chittagong, Burma and the Andaman Islands. An alcoholic drink is made from it and I understand a small amount of sugar also. In the Philippine Islands it is used to a considerable extent for sugar making and alcohol production."

The following extracts are from a paper by Mr. H. D. Gibbs of the Bureau of Science, Manila, read at the Eighth

* *c.f.* The Date Palm Sugar Industry, by H. E. Annett, Memoirs of the Department of Agriculture in India, Vol. II, No. 6, Chemical Series.

International Congress of Applied Chemistry, and since printed in the "Louisiana Planter":—

"Since the Nipa is the only palm which promises to be of any great commercial importance as a producer of sugar sap, no others will be considered here.

"It is an erect, stemless palm, the leaves and inflorescences rising from a branched root stock, the leaves pinnate, 3 to 10 meters long. The inflorescence starts from near the base of the leaves, erect, brown, 1 to 1·5 or 2 meters high, bearing numerous sheathing spathes, and both male and female flowers. This palm grows only along the mouth of tidal rivers in low tide lands subject to overflow of brackish water as the tides rise each day, and it will not thrive in localities where either fresh or sea water alone is available. It reproduces itself and in many localities extends its growing area, encroaching upon the sea. Nipa swamps of considerable size and importance occur in a number of the provinces of the Philippines. Swamp lands, subject to daily overflow by the tides, to the uninitiated would appear to be of no value, but this palm, growing in great abundance in these localities, gives a profitable crop when properly exploited.

"Since the Nipa palm sends its inflorescence up from the base, and hence is near the ground, the flower stalk is conveniently situated for the gathering of sap. Four years after planting the seed, it bears fruit, but it is not tapped for its sap until the fifth year. Some time after the fruit has formed, the stalk is cut across near its top, usually just below the fruit, and each day a thin slice is removed to keep the wound fresh and to facilitate exudation. The sap, as it flows from the stalk, is clear and transparent, almost colorless, and very sweet to the taste. It is collected in small receptacles, usually once a day, and transported in boats to the distilleries. In some districts palms, which are to-day in a perfectly healthy and thriving condition, have been known to have yielded sap on a commercial basis for the past 50 years. The industry is in many respects capable of improvement, which would lead to greater profit. * * * *

"The Nipa palm sap is probably the cheapest raw material now being utilized for the production of alcohol and alcoholic beverages. The industry is confined to the Philippine Islands, where it reaches considerable magnitude, over 90,000,000 litres of sap being produced yearly, and distilled in pot stills, continuous process stills and modern rectifiers. The pot stills produce a beverage varying in composition from 20 to 55 per cent. alcohol, the continuous process stills, alcohol of about 50 per cent. purity and the modern rectifiers, 93 to 96 per cent. spirits. One of the distilleries now in operation is producing 93 per cent. alcohol at a cost of less than 0·04 dollars (United States currency) per litre.

"Sugar is not produced in commercial quantities from the sap of the Nipa palm, but all indications point to the possibility of creating a profitable industry of considerable magnitude. A conservative estimate of production is as follows:—2,000 palms per hectare yield 36,000 litres of sap, containing 12 per cent. recoverable sugar, equivalent to 10,750 kilograms of 96 per cent. centrifugal sugar.* An equipment corresponding to a 500-ton sugar mill can be kept running for 180 days of the year on the sap from 750 to 1,000 hectares† of Nipa lands, and should produce annually about 9,000 tons of 96 per cent. sugar.

"The cost of refining will probably be approximately the same as for cane-sugar, for, owing to the absence of bagasse, fuel will have to be purchased, opposed to which is a saving due to the absence of crushers. The sap arrives at the mill in the same condition as the juice of the sugar-cane after the addition of the lime.

"In order to inhibit inversion of the sucrose of the juice, the collecting vessels must be coated with a thick mixture of lime and water before being placed in position to collect the sap droppings from the cut stem. Sap has been found to undergo no change in 10 days when treated in this way.

"The refining of this sap will require, with the exception of the crusher, the ordinary equipment of a sugar mill, and at

* Over 4 tons per acre

† 2,000—2,500 acres.

present I am strongly of the opinion that more profit is to be made from the Nipa lands through the establishment of sugar refineries than distilleries. I fully appreciate that claims which never have been realized have been made for the profits to be derived from the use of other palms, *Arnega saccharifera* and *Caryota urens*, in Java and India, for sugar production on a commercial scale attractive to the investment of European and American capital. However, in the case of the Nipa, many of the difficulties encountered with other palms do not exist. Some of the points of special advantage to the Nipa are as follows:—

"The swamps now exist in a state ready to bring them into active production merely by thinning, or, in the case of the swamps employed in the alcohol industry, this work is already well under way; many large areas are not now put to any use and are to be had for a small investment; the plants reproduce themselves and it is probable that each plant is capable of producing for more than fifty years; the flower stems are close to the ground and the work of gathering the sap is quickly and easily performed; the producing plants grow very close together and the production per hectare is large: transportation of the sap is cheaply accomplished through the numerous waterways, and may be still further reduced by the construction of pipe lines.

"In conclusion I must point out that while these estimates are the results of accurate laboratory and field investigations they must be substantiated on a small factory scale. If no unforeseen difficulty is encountered, I believe splendid returns will accrue."

The conditions under which this palm grows in the Sunderbans, would seem to be worth investigation by capitalists. (A. C. Dobbs.)

* * *

The Sterilisation of Seeds.—Numerous methods are in use for destroying the micro-organisms which occur on or in the coats of seeds. The most general method consists in washing the seed

with an antiseptic, such as corrosive sublimate. A new process, which appears to give yet more satisfactory results, is described by Messrs. Pinory and Magron in the *Bulletin de la Société Botanique de France* (Vol. 59, 1912, page 609). This process, which has been employed also by others, consists in immersing the seeds in commercial hydrogen peroxide. According to the observations of the authors cited, hydrogen-peroxide is efficacious in destroying micro-organisms and produces no harmful effect on the seeds, even though the latter be soaked in it for many hours. Messrs. Pinory and Magron state, moreover, that hydrogen-peroxide exercises an accelerating influence on germination. Peas treated with the re-agent began to grow a day and-a-half before similar, untreated seed, and seed of *Orobus tuberosus*, treated previously with peroxide, germinated in 8 days—as against 28 days taken by untreated seed. These facts, if they prove to be generally true, are of considerable importance, not only from a scientific and theoretical point of view, but also from that of practice. To give but one illustration, the seeds of many grasses germinate with extreme slowness: if they could be made to germinate in the course of a few days, not only would time be gained but loss from birds and ground animals would be reduced.—*The Gardeners' Chronicle.*

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Coffee Manuring on a Scientific Basis.—We take the following letter from the *Planters' Chronicle*, the official organ of the United Planters' Association of Southern India—as illustrating the advantages of seeking technical advice in cases where it is proposed to remedy marked deficiency of cropping power by manuring.

"I think the results obtained from 3 years' cultivation and manuring according to a scheme proposed by our Scientific Officer, Mr. R. D. Anstead, should be of interest to all readers of the *Planters' Chronicle* interested in coffee—and, I may say, of advantage. Like many other fellow-planters, year after year I applied manures, usually nitrogenous, and in the usual style,

My 50 acres of bearing coffee on one Estate, and 100 acres on another, replied to my best efforts with crops of 5—6 tons on the former, and 14—15 on the latter. From 1902—1910 the former averaged 5 tons, and the latter 14½ tons for 8 years. The manures applied averaged 4 cwts. per acre, consisting mainly of poonac, with bone added occasionally, and in other years fish. The cost worked out to about Rs. 20 per acre and I thought I was doing the places well. The Estates looked well and year after year I looked for the bumper that never came! If I got anything like a decent crop (4—5 cwts. per acre) the following year it dropped to 2 cwts. In parts of the Estate the trees had a "cabbagy" look. Failure began to pall on me, and the arrival of our Scientific Officer made me say to myself, "why not begin all over again, get my soils analysed thoroughly well, and seek Mr. Anstead's advice?" This I did, sending 4 samples to Mr. Alfred Gordon Salmon, Fenchurch Avenue, E.C., who did the analyses very thoroughly, and charged £5-5-0 per sample. I sent these analyses to Mr. Anstead and asked his advice. He took every trouble in working out a 3 years' scheme,——or rather 2 years, and, after seeing the results last November, he was able to advise for another year. I accepted his advice without question. Before giving the scheme he asked a number of questions *re* rainfall, elevation, aspect, etc., and what I was prepared to spend per acre. To the latter I replied, Rs. 25, *plus* cartage. This worked out eventually to about Rs. 32 per acre, or an increase of Rs. 12 to what I had been spending. My crop went up, on the 50 acres, from 9 the previous year to 10 tons, and from 10 to 18; on the 100 acres, from 9 the previous year to 38, followed by 21. I therefore, on the 150 acres, spent Rs. 1,800 more on manures (which was equal to about 1½ tons of crop), and for this increase my crop doubled itself. This year I am expecting (with anything like good rain, which has not come yet, April 7th!) 18—20 tons on the 50 acres, and 30—35 on the 100 acres. If this comes off, and I see no reason why it should not with good rain, I shall average 15 tons for 3 years off the 50 acres, and 30 tons off the 100, against 5 tons for 8 years, and 14½

tons. The whole aspect of the Estates has changed and parts which were "cabbagy" are now vigorous, with a good spread and long spiky close knotted wood. Parts which have just given 8—10 cwts. an acre are scarcely feeling it, and will give 6—7, while other parts which have just given 6—7 are doing the same again. A neighbouring Estate carrying out a scheme on the same lines is having good results also, after a succession of heart-burning failures. Readers will say "yes, you just happened to hit good seasons, wait and see!" I am open to wait and see, and meanwhile instead of a deficit every other year which is far too common on most Estates, I can show handsome profits for 2 consecutive years, and see no reason why I should get a deficit again, provided I carry on manuring and cultivation in the sound way recommended by our Scientific Officer, whose excellent article on manuring, in the *Planters' Chronicle* for January 25th most of us must have read. In addition to my crops increasing, the quality of the bean has vastly improved also. Last year one lot topped the market, and the rest also sold well. Previously the coffee from these Estates used to be in the same boat as many others and realized very ordinary prices. The report, since I started manuring on the lines laid down by Mr. Anstead, is invariably good, and the liquor "exceptionally good."

(Sd.) P. M. WILKINS.

REVIEWS.

THE COTTON WORM IN EGYPT, BY GERALD C. DUDGEON, F.E.S. — A paper originally contributed to the British Section of the International Association for Tropical Agriculture and subsequently printed as a special article in the Bulletin of the Imperial Institute, has been issued separately under the above title. In it the author gives a very useful account of the history of the cotton worm (*Prodenia litura*) and incidentally a history of the development of cotton growing in Egypt. A summary is given of the complete life history of the insect as worked out by F. C. Willcocks, which is very similar to the life history of *Prodenia* in India. The insect is of peculiar interest because it is one which was present in the country before the cotton crop was of importance, and seized upon the newly introduced crops which flourished at a time when other food was scarce. A detailed account of the occurrence of the insect in the early years of the development of the cotton industry is given, and the gradual recognition by the authorities of the seriousness of the pest and the measures adopted for combating it. The first method which was tried with any great measure of success was picking and burning of egg-masses and larvæ, and although this did not always meet with success, it is clearly pointed out that the failure was more due to inefficiency of organisation than to the method itself, and that a campaign on these lines organised and carried out by the new Agricultural Service proved successful.

An extremely interesting point is the occurrence of a disease caused by a micro-organism (*Microsporidium polyedricum*) which does great execution among the worms, and is apparently indigenous. Another point of extreme interest to Indian cotton growers is that, although the same insect occurs in India as a

pest of tobacco, etc., yet it has in this country never turned its attention to cotton, the most important Indian cotton pest being the cotton boll-worm, which directly attacks the cotton bolls, whereas the cotton worm of Egypt mainly attacks the leaves.

The author also includes an account of the regulations issued by the administrative authorities at various times, and shows that such methods can, when carried out by a competent staff, effect a great deal and prevent much loss. At the end of the article a brief summary is given of the report of the Commission appointed by Lord Kitchener to consider the cotton worm and the cotton boll-worm pests of cotton, and of the measures suggested for combating them. An interesting chart is also given showing the yield of cotton and the severity of the cotton worm attack from 1890 to 1912.—(A. J. G.)

* * *

We are indebted to Babu Jamini Kumar Biswas, Superintendent of the Rangpur Tobacco Farm, for a copy of his book "Tamakar Chash" (printed at the College Press, 117-1, Bow Bazar Street, Calcutta. Price, Re. 1-8).

The book, which is written in Bengali, contains 136 pages. It deals with the cultivation and curing of tobacco for ordinary use in India and for cigar and cigarette making. The first three pages are devoted to the history of tobacco—its discovery in Cuba in 1492, and its introduction into Europe and Asia. Pages 6 to 14 describe the efforts of Government and private persons to introduce exotic varieties of tobacco into India.

The language in which the varieties of tobacco are described on pages 21 to 28 is too technical to be understood by plain people and could be suitably replaced by ordinary Bengali.

The outturn per acre in Rangpur is stated by the author on page 78 to be from 15 to 20 maunds—or 10 to 12 *kahans* per bigha, and on page 89 he estimates the value of the outturn at 32 *kahans* per acre worth Rs. 6 per *kahan*, making a total, after adding Rs. 2 as the value of leaves rejected at the time of pruning, of Rs. 194 per acre. Allowing Rs. 116 for total expenditure a profit is shewn of Rs. 78 per acre.

The reviewer's experience in Tirhoot would indicate that this figure is too high. The profit in the latter district is given in a recent leaflet on the subject published by the Department of Agriculture, Bengal, as Rs. 20 per acre, but allowances must of course be made for variations in price and quality.

On the whole the book is a good one and should be useful to Bengali tobacco growers.—(N. C. C.)

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THE INDIAN FOREST RECORDS, Vol. IV, Pt. III. USEFUL EXOTICS IN INDIAN FORESTS BY R. S. HOLE, F.C.H., F.L.S., F.E.S. PRINTED AT THE GOVERNMENT PRESS, CALCUTTA. Price As. 4 or 5*d*.

WHAT promises to be a useful series of monographs has been inaugurated under the above general title in the Indian Forest Records.

An introduction of 19 pages, devoted to a discussion of the value of exotics generally and the necessity for careful choice and preliminary trials, will well repay perusal—particularly by those to whom the mere casual importation of seed of desirable plants appears to be an easy and rapid method of rural economic development.

The subject of the first of these monographs is *Prosopis juliflora, DC.* the Mesquit Bean, a form of which has been successfully introduced into Sind where, at Miani near Hyderabad, it has spread spontaneously and saved the Monument Garden from the inroads of shifting sands.

The pods provide a useful fodder in such desert regions.—(A. C. D.)

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DEPARTMENTAL PUBLICATIONS.

THE first annual report of the Agricultural Stations of the North-West Frontier Province (printed by Messrs. Thacker, Spink & Co., Calcutta) has recently been issued. The work recorded relates chiefly to experiments in the introduction of new

implements, crops, and varieties of crops and fruits. European introductions appear to have a better prospect of success in this far Northern corner than elsewhere in India,—among those that promise well being rye grass and some English varieties of cereals. Even blackberries, imported from France in 1911, have borne good fruit. Twenty-two acres are planted with fruit trees at Taru. Several early varieties of peaches have been introduced, which it is hoped will enable Peshawar growers to market this fruit fully a month earlier than at present. Superior varieties of grapes and oranges are also being experimented with.

A variety of the Mesquit bean (*c.f.* above, p. 305) has done well at Peshawar and is being tried on a large scale at Dera Ismail Khan.

An unwelcome introduction is berseem dodder, which is almost invariably imported with the seed of berseem from Egypt. A recent abstract in the Bulletin of Agricultural Intelligence and Plant Diseases issued by the International Institute of Agriculture, Rome (January, 1913), indicates that this dodder is a specific variety which has been named *Cuscuta aegyptiaca* and it would seem advisable to take special precautions to raise clean seed of berseem in India while it is still possible to keep this dodder out

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THE Central Provinces Agricultural and Co-operative Gazette (printed at the Deshasewak Press, Nagpur, Annual subscription Re. 1) continues to provide interesting reading for the large number of its subscribers.

Besides shorter notes and notices, the December and January issues contain articles on Sugarcane cultivation in India by Mr. McGlashan and, under the title of Agriculture and Co-operation, an account of the important conference of Agricultural Associations held at Akola, in November, at which it was decided to establish "Co-operative Unions" for the maintenance of pure seed of cotton and other crops.

A lecture by Major Baldrey, on cattle breeding, has been appearing serially since February, and will be followed by a second having special reference to the cattle of the Central Provinces.

The notes of the Registrar of Co-operative Societies give an insight that is of more than provincial interest into the practical working of these societies in the Central Provinces, and are supplemented by interesting accounts of the famous Jena glass works—"A Factory that owns itself," and of "Raiffeisen —the Founder of Village Banks," in the February and March issues respectively.

THE Bombay Department of Agriculture has issued as a Bulletin (No. 54 of 1912) a note on steam ploughing by Mr. Musto of the P. W. D., recently Agricultural Engineer in the Bombay Presidency (printed at the Government Central Press, Bombay. Price annas 10 or 11*d*.)

While on leave in England in the autumn of 1911, Mr. Musto, on his own initiative, spent 5 weeks investigating the subject of mechanical power cultivation, and the bulletin may be taken as an authoritative exposition of the present economic value of the various available systems. A steam plant is only recommended for deep ploughing of large areas, and particularly for the eradication of the strong *Hariali* grass which can only be got rid of by turning up the soil to a depth of some 16 inches.

Briefly, the author's conclusions are overwhelmingly in favour of the simple system of drawing tillage implements backwards and forwards, between two engines on opposite sides of the area to be cultivated, by means of cables. This is known as the double engine system. The engines move step by step alternately along headlands some 440 yards apart, cultivating the land between them.

The chief disadvantage of the system is the heavy initial cost of the smallest efficient plant, which comes to about Rs. 40,000—and will plough about 8 acres a day of hard black cotton-soil, to a depth of 16 to 18 inches, and 20 acres or more to half that depth. The cost per acre, however, if the machinery can be kept employed for 130 days in the year, is estimated by Mr. Musto at less than Rs. 15 in the former case, and less than Rs. 6 in the latter.

Two or three such plants are about to receive a trial in India.

THE Burma Department of Agriculture has issued a Bulletin (No. 8 of 1912, price annas 12) on Cotton Pests in Burma. It contains a short account by Mr. K. D. Shroff, Assistant Entomologist, of 14 pests, with suggestions for minimising the damage done by them.

THE Journal of the Madras Agricultural Students' Union is issued quarterly from the College at Coimbatore, the subscription being Re. 1 a year. The 2nd issue, dated January 1913, contains, among other notes of local interest and articles, a short account of the Madras Agricultural Stations and the objects aimed at in their work up to the present time. It is proposed to follow this up, in future issues, with a series of "Farm Notes" summarising the work of the Stations, and drawing attention to any experimental data which may have been evolved.

This should prove a useful current review of the experimental work of the Madras Agricultural Department, and ought to attract the attention of agriculturists in that Province to the work of the Agricultural Stations.

A paper entitled "Agriculture and my Experience on the Working of my Farm" read at the Madras Agricultural Conference in July, 1912, by Mr. Vengail Krishnan Nayanar, a landowner of N. Malabar who was for some time a student of the College at Coimbatore, is one of several interesting appendices to the account of that Conference begun in the previous issue of the Journal under review.—(A. C. D.)

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TROPICAL AGRICULTURIST.—We are asked to state that the "Tropical Agriculturist" has been purchased by the Ceylon Agricultural Society—who are now sole proprietors—and is obtainable from the office of that Society at Peradeniya. The issue for April 1913 is an interesting one, and contains as a supplement the report of the Committee appointed by the Board of Agriculture, Ceylon, to arouse public interest in the question of a College of Tropical Agriculture and to point out the advantages of Ceylon as a site for such a College.

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA.

TO BE HAD FROM MESSRS. THACKER, SPINK & CO., CALCUTTA.

Annual Report of the Imperial Department of Agriculture in India, for the year 1904-05. Price, As. 12 or 1s. 2d. (*Out of print.*)

Report of the Imperial Department of Agriculture in India, for the years 1905-06 and 1906-07. Price, As. 6 or 7d.

Report of the Agricultural Research Institute and College, Pusa (including Report of the Imperial Cotton Specialist), for the years 1907-09. Price, As. 4.

Report of the Agricultural Research Institute and College, Pusa (including Report of the Imperial Cotton Specialist), for the year 1909-10. Price, As. 4 or 5d.

Report of the Agricultural Research Institute and College, Pusa (including Report of the Imperial Cotton Specialist), for 1910-11. Price, As. 6 or 7d.

Report of the Agricultural Research Institute and College, Pusa (including Report of the Imperial Cotton Specialist), for 1911-12. Price, As. 6 or 7d.

Report on the Progress of Agriculture in India, for the years 1907-09. Price, As. 6 or 7d.

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Report on the Progress of Agriculture in India, for 1911-12. Price, As. 6 or 7d.

Proceedings of the Board of Agriculture in India, held at Pusa on the 6th January 1905 and following days (with Appendices). Price, As. 8 or 9d.

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Proceedings of the Board of Agriculture in India, held at Cawnpur on the 18th February 1907 and following days (with Appendices). Price, Re. 1-2 or 1s. 6d.

Proceedings of the Board of Agriculture in India, held at Pusa on the 17th February 1908 and following days (with Appendices). Price, As. 8 or 9d.

Proceedings of the Board of Agriculture in India, held at Nagpur on the 15th February 1909 and following days (with Appendices). Price, As. 8 or 9d.

Proceedings of the Board of Agriculture in India, held at Pusa on the 21st February 1910 and following days (with Appendices). Price, As. 8 or 9d.

Proceedings of the Board of Agriculture in India, held at Pusa on the 29th November 1911 and following days (with Appendices). Price, As. 10 or 1s.

Standard Curriculum for Provincial Agricultural Colleges as recommended by the Board of Agriculture, 1908. Price, As. 4 or 5d.

The "*Agricultural Journal of India.*" A Quarterly Journal dealing with subjects connected with field and garden crops, economic plants and fruits, soils, manures, methods of cultivation, irrigation, climatic conditions, insect pests, fungus diseases, co-operative credit, agricultural cattle, farm implements and other agricultural matters in India. Illustrations, including coloured plates, form a prominent feature of the Journal. It is edited by the Agricultural Adviser to the Government of India, assisted by an Advisory Committee of the Staff of the Agricultural Research Institute, Pusa. *Annual Subscription*, Rs. 6 or 8s. 6d. including postage. Single copy, Rs. 2.

MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA are issued from time to time as matter is available, in separate series, such as Chemistry, Botany, Entomology and the like.

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